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The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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## Foundry Lighting

It is perhaps appropriate that this, our thousandth, issue should contain an authoritative article on foundry lighting by Mr. Daniel, a factory inspector, as lighting is so fundamental in the proper conduct of a modern business. It is apposite to recall that some fourteen years ago we called upon a foundry in the East End of one of our big cities, and the lighting was so poor that we inadvertently knocked over a water pot. Several weeks later we again called on the same foundry and saw the same pot, now half-buried in sand! The most important feature that has arisen from recent discussions on foundry lighting is that by the use of the latest mercury vapour—or at least the type which makes one look so ghastly—the actual nature of the sand can be seen. Whilst artificial lighting assumes an ever-increasing importance, the admission of daylight also demands equal attention from those responsible for the proper conduct of a foundry. New buildings should be so designed that this work is facilitated by elevated gangways and a handy water supply.

One firm near Sheffield has installed an invisible-ray apparatus, which automatically switches on the lights, when a predetermined intensity of illumination fails to be maintained. This, of course, precludes the burning of lights unnecessarily and prevents the straining of eyesight owing to the gradual and imperceptible decrease of daylight. Facts have been produced to show that production is increased with adequate illumination, and that the cost of installation and especially proper maintenance is quickly repaid. It is our ambition that the foundry industry, possessing the inherent disadvantage of handling so much black material, may lead the way in the matter of a high reputation for the provision of well-lit and adequately-ventilated shops. Whilst we are pressing for a high standard of general illumination, provision must be made in shops working day shift only for a proper provision of local lighting for the small night gang of maintenance men and the like, in order to make for reasonable economy.

## Another Step Forward

We were able to announce a short time ago the decision of the Governing Body of the British Foundry School to open the school for its first session this month and, as will be seen from our news columns, this was actually carried out two days ago. The school opens with no less than eleven students, which may be regarded as a very promising beginning. We need not reiterate the circumstances which have led up to the scheme in detail. It suffices to say that training of the kind contemplated has for some time been available in several other countries, and a scheme had to be worked out to suit British conditions. The number of students registered appears to be very representative of both large and small firms, covering iron, steel and non-ferrous foundries, and of foundries forming part of larger works as well as those we have described as detached. We feel sure that those whose privilege it is to undertake the course will begin a sound and wholesome tradition, and that their subsequent success will be a true measure of the prestige which will attach to the school's diploma. We say it is a privilege advisedly because it needs courage on the part of a firm, or of a young man (or his parents) to provide the means to enable the course to be taken, and when students are relatively matured the cost is higher. Furthermore, the fees do not, of course, cover more than a fraction of the cost involved. The scheme has been made possible by the co-operation of a number of bodies and interests. It was needed because developments have been very rapid in recent years, and the sum total of the knowledge required by the modern foundry executive makes the part-time method of education, such as by evening study, inadequate. Those who graduate from the school will be watched as the men of the future in the industry, and those who are best acquainted with the problems and difficulties of the industry know how badly they are needed. We trust that the school, so unobtrusively begun, will find a sphere of increasing usefulness.



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# "Number One Thousand"

In January, 1902, THE FOUNDRY TRADE JOURNAL made a modest entrance upon the stage of technical publication. Its first page reproduced a paragraph from the "Daily Express," headed "Schwab's Boast." There was, perhaps, a tacit implication that the foundry industry is dependent on the iron and steel trades, which is not quite true. Overleaf, on page 2, the Editor simply, yet clearly, expressed his ideals of service to the industry, and to these, after a lapse of thirty-three years, we have nothing to add nor to modify. His Introduction reads as follows:—

## INTRODUCTION

THE Foundry Trade has, up to the present, been sadly neglected in the way of literature of a trade nature, devoted specially to its advancement and interest; existing trade journals only touch very lightly on Foundry practices.

Foundrymen in general have long felt the want of a good medium for the exchange of ideas and experiences, and the illustration of the improved methods that from time to time are placed upon the market. Without this interchange it is impossible to estimate the advantage to be gained by adopting advanced ideas that have already been tested and found profitable.

There is no doubt that in this country the Foundry has been greatly neglected, and allowed to remain in almost the same state for nearly a century. It is a well-known fact that in some Foundries no improvement has been made upon the tools that were in use fifty years ago, and, in some cases, are still in use to-day, restricting the possible output to a very great extent, and making it very difficult for English firms to compete on terms with those of other countries.

Our Journal is instituted to illustrate and advise Foundry-masters of the best means of facilitating and improving the manufacture of castings of all descriptions.

It is our main object to bring before our readers those articles of machinery, etc., that have been adopted in this and other countries, to the advantage both commercially and financially of the Trade.

Unless some radical improvements are introduced, and methods of production brought more into line with those of other countries, England will find herself gradually driven out of the markets which for many years she has regarded as entirely her own.

We hope our readers will support us in our endeavour to ameliorate and enhance the well-being of the Foundry, raising it in importance and to the level hitherto enjoyed so exclusively by the machine shops.

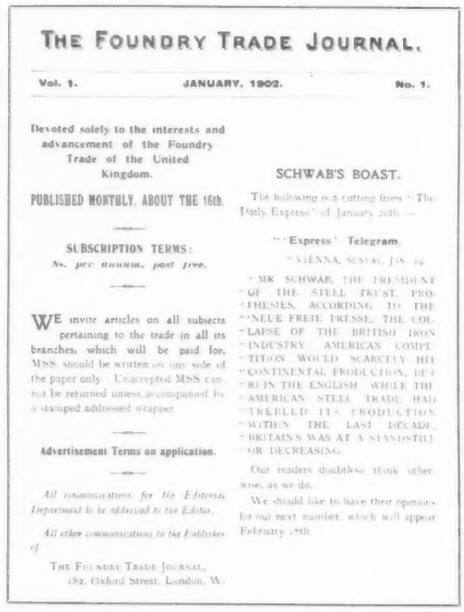
We shall endeavour to run this Journal on the highest plane of trade journalism, employing the best writers that can be obtained, and publishing their ideas in a succinct and readable manner. We wish to make our Journal a book of ready reference to our readers. Our aim is *utility*—to become the necessity of the greatest number; not to be a magazine that only appeals to a few.

The contents of the first issue included a description of Alfred Herbert's foundry in Coventry; mechanical treatment of sand; machine-cast pig-iron, and "Free Trade: Its Danger to British Industry" (by Mr. G. Byng, of the General Electric Company).

With the second issue there came through the correspondence column a demand for the creation of a technical institute for foundrymen. Though *nom de plumes* were used, it is now known that the first letter received was from the late Mr. James Ellis. It took two years before the British Foundrymen's Association was definitely established, and THE FOUNDRY TRADE JOURNAL was appointed as its official organ, a position it still holds after thirty-one years.

Passing on to number 100, which appeared in April, 1910, there were two leaderettes of considerable interest. The first dealt with the then new vogue of scrapping machinery when still serviceable, providing something more efficient was available, whilst the second referred to the use of concrete patterns instead of wooden ones! This issue also contained a brilliant article by Mr. J. Shaw on "Moulding Sands"; a really practical one on "Runners, Gates and Dirty Castings," by F. A. (we wonder if this hides the name of Mr. F. Andrew, now foundry manager to Ferranti's); "Calculating the Average Price of Castings," by Dr. R. Grimshaw; "The Preparation of Phosphor-Bronze for Castings," by A. Napier, and "Foundry Coke," by Mr. E. L. Rhead.

The two-hundredth issue was published three months before the Armistice in August, 1918. The paper used shows signs of "economic pressure" and is below the usual standard. Naturally



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182, Oxford Street, London, W.

SCHWAB'S BOAST.

The following is a cutting from "The Daily Express" of January 20th:—

"'Express' Telegram.

"VIENNA, SUNDAY, JAN. 19.

"MR. SCHWAB, THE PRESIDENT OF THE STEEL TRUST, PROPHESIES, ACCORDING TO THE 'NEUE FREIE PRESSE,' THE COLLAPSE OF THE BRITISH IRON INDUSTRY. AMERICAN COMPETITION WOULD SCARCELY BE CONTINENTAL PRODUCTION, BUT RUIN THE ENGLISH. WHILE THE AMERICAN STEEL TRADE HAD TREBLED ITS PRODUCTION WITHIN THE LAST DECADE, BRITAIN'S WAS AT A STANDSTILL OR DECREASING.

Our readers doubtless think otherwise, as we do.

We should like to have their opinions for our next number, which will appear February 15th.

enough, the contents are also largely influenced by the war and the leader deals with the then new Non-ferrous Metals Act; a second article studies the "Position of the Iron and Steel Trades after the War," whilst a third was on "Metal Substitutes in Germany." There are articles on the "Deformation of Castings," by Mr. T. Brown, of Sheffield; "Cupola Blowing and Efficient Combustion," by Captain Alex Hayes, the then Editor, and the "Stobie 15-ton Electric Furnace."

In January, 1921, the proprietors of THE FOUNDRY TRADE JOURNAL decided to publish weekly, and to incorporate with it the "Iron and Steel Journal," a paper which ranked amongst the oldest trade papers in the world. It was at this time that the Journal came under our personal editorial direction.

Issue number 500 appeared on March 18, 1926, a few weeks before the general strike was declared, which caused the non-appearance of number 508, whilst 507 consisted of a few typewritten broadsheets. By a curious coincidence the leading article in number 500 also dealt with the problem of "To Scrap or not to Scrap." Amongst other articles was one upon the "Die-Casting of Aluminium Alloys," by Captain George Mortimer; "The Drying Stoves at Mr. Smith's Foundry in South Shields"; "Foundry Costing," by Mr. C. Dicken, and "Gases Evolved from Heated Iron," by Mr. Ben Hird. The following autumn the Journal assumed its present three-column make-up in order to cope with the increasing output of technical matter.

This survey has impressed upon us the fact that a complete set of the Journals undoubtedly constitutes the finest textbook on foundry practice available to the technician. We were somewhat flattered when a very prominent foundry owner from South Africa wrote to us that his business had been built up on information culled from our columns. We feel that this is an appropriate occasion to express our very sincere thanks to our advertisers, as it is only by their loyal support that such straight-line progress has been consistently registered over a period of thirty-three years.

## Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

### The Soda-Ash Process in the Foundry

*To the Editor of* THE FOUNDRY TRADE JOURNAL.

SIR,—May I draw your attention to an error in your report of the above Paper by M. Lefebvre in your issue of September 26? Referring to the improvements obtainable in the quality of converter steel by treating the iron with sodium carbonate prior to conversion, M. Lefebvre actually said: "The physical qualities of the steel obtained, that is, the tensile strength, elongation and resilience, are improved *in a much greater degree* than could be attributed to desulphurisation alone." This, as you will appreciate, is not quite the same as your report, which reads: "The physical qualities . . . are improved considerably, due entirely to the sole fact of desulphurisation."

M. Lefebvre's statement is in complete agreement with, for example, the opinion of Mr. J. Deschamps in the discussion of the writer's Paper on this subject (THE FOUNDRY TRADE JOURNAL, December 22, 1932, p. 381), and the statement appearing in your account of a well-known steel foundry (THE FOUNDRY TRADE JOURNAL, December 24, 1931, p. 396), viz.: "In common with other steel-castings manufacturers the technical staff attached to this concern believe that, while sulphur reduction is effected, other beneficial properties are bestowed on the metal."—Yours, etc.,

N. L. EVANS.

I.C.I. (Alkali), Limited,
Northwich, Cheshire.
October 12, 1935.

## Publication Received

**Reducing Danger from Circular Saws.** Published by the National Employers Mutual General Insurance Association, Limited, 10, St. Mary Axe, London, E.C.3. Price 3d.

In this booklet are 16 pages of really practical information, the observance of which will increase and not diminish production, due to the confidence a man will have in his work. We would specially call attention to the illustration on page 10, which shows the operative using a push stick for feeding the wood through the machine. The actual design of push stick recommended is shown on page 12, where a metal band near the "business" end forms an added protection against splitting. There is a wealth of information about guarding moving knives and "stance" for operators. We strongly counsel all our readers to purchase copies of this for use in their pattern shops.

# Lighting in Foundries*

By J. W. DANIEL

Industrial lighting represents no new problem; rather it is time honoured, but the indifferent, often lamentable, conditions still prevail. Few tolerate ill-lit homes, or ill-lit places of entertainment, yet in many industrial areas ill-lit factories and workplaces are still the rule rather than the exception. With improving trade conditions, new premises, well built and well lit, are springing up; in others, drastic modernisation has done much to lighten working conditions. Many still adhere to the old order, and dimly-lit conditions continue unchecked. The fact must be faced that many foundries come within this category. Many of the larger, more modern concerns are tolerably, and a few lavishly, lit. Elsewhere very poor standards still prevail. Foundries are inevitably dusty and dirt-creating places. Such conditions unite with the naturally dark colours of material and plant in common use, to detract from whatever light is available. Yet the evil of bad lighting is twofold; it is prejudicial to the health, comfort and safety of the workman, and detrimental to the quality and output of the work. Good lighting, the ability to see, conquers both.

The term industrial lighting includes both natural and artificial lighting. The latter is but an aid to the former, yet natural lighting even, free and unlimited, received far less attention than it deserves. Whilst modern buildings, veritable crystal palaces of industry, bow to the demand for light and air, many buildings of incredible interior gloom still remain. Even in these, limewash and clean windows cost so little, yet can achieve so much. The contrast in almost any foundry before and after limewashing is amazing. The advantages are apparent.

Artificial lighting is the major consideration. Its origin is as old as fire, but until comparatively recent years it has been regarded as something of a luxury; one old-time authority terms it "a convenience and an aid to revelry." Now, to-day, industrial lighting, like most other modern industrial devices, knows no half-measures; it must either be good or it is bad.

What standards of illumination do actually prevail in the industry at the present time? In order to assess these, it is necessary to understand the broad principles by which any lighting installation, good or bad, is judged, and the units in which it is measured. The dual conditions of a good system are, that it must be adequate, and that it must be suitable. The actual amount of light cast on a working plane, having in view the accuracy or "fineness" of the work in hand, is a measure of its adequacy—or lack of it.

It may be expressed alternatively as "the intensity of illumination available," and is usually expressed in foot-candle units. One foot-candle is the intensity of light received on a given surface from one standard candle, at one-foot distance. Thus, a given process will need to be illuminated to an intensity of so many f.c., and if, and only it, it is, can it be efficiently carried on. The actual figure naturally varies greatly with the process involved, and is usually obtained in a particular instance, by suitable tests or comparisons. For foundry work in particular, different authorities may suggest different values, the expression of an opinion. For the purposes of present comparison, an arbitrary minimum for effective foundry-floor lighting, a modest 2 f.c. may be assumed. The several finer and more intricate processes of the moulder's trade, are now, if one can visualise it, each lit by two candles, distant one foot. Bearing in mind that the material is dark, and that the light is fixed, that it cannot be moved to eliminate shadows cast by projections in the depth of the moulds, etc., few would suggest the allowance to be generous. This room is probably lit to about 20 f.c. intensity, 10 times as great. The general lighting of many modern factories is between 10 and 20 f.c., sometimes more. Indeed, the two f.c. ration seems to grow niggardly by contrast.

How, then, does it compare with conditions prevailing in practice? A recent inquiry throws some light—or, more aptly, darkness—on this point. In the winter of 1932-33, approximately thirty factories were visited in one large industrial city during hours of darkness. In most of them photometric readings of the actual light available at working points were taken in number. Only 29 per cent. of these possessed a modest 2 f.c. or more, generally over the foundry floor. Only 10 per cent. exceeded an average of 5 f.c. In 52 per cent. less than 1 f.c. was available and in 23 per cent., nearly one-quarter, less than half a foot candle provided the sole aid to sight.

Conditions in this area, moreover, do not seem to differ materially to those commonly prevailing throughout the country. Investigations in foundries generally made within recent years reveal very similar conditions. What must be the effect? No man whose eyes are strained by gloom or glare can give his best. Remedy this defect and the advantage is apparent. Mental and physical time-lag are reduced; the workman, more comfortable, is subconsciously more productive. Indeed, it may be taken as a truism that improved lighting must necessarily produce improved output. Alongside this purely material aspect is a parallel improvement in the welfare of the operative. Numerous results are available showing percentage increases in output, following increases in factory illumination. One example, although fairly widely known, is worthy of yet further mention.

In a particularly gloomy workroom women workers formed clay tiles in small hand presses. It was shown that they could, without difficulty, carry on this process blindfold. Yet when the room was adequately and "warmly" re-lit the psychological result of brighter and more cheerful surroundings increased the output by 12 per cent. In the case of fine or accurate processes, of course, there is the even more important consideration of the need of sufficient light for clear vision. Even fractions of seconds lost in peering and fumbling accumulate in quantity during working hours to form an appreciable amount of wasted time. Yet an erroneous theory that good lighting is quite unnecessary in the foundry trade is still common among employer and employee alike, and even the coarsest work involved is more precise than clay pressing.

### The Essentials of Good Foundry Lighting

To have real value, the installation must satisfy two major requirements, previously mentioned—adequacy and suitability. Artificial-lighting illumination of interiors may be divided into two broad systems, purely general lighting and combinations of both general and local lighting. General lighting is the system usually adopted in theatres, public halls and the home. The light sources comprise large units, spaced at calculated intervals, situated well above head level, and providing approximately uniform illumination over the floor beneath. It represents the system used in practically all foundries. In the theatre this general lighting provides an intensity sufficient to make the interior cheerful, and to provide safe access to and from the seats.

In the shop or home it must facilitate examination of goods or reading of print, and must be stronger and more intense. In a foundry, light sufficient only to permit safe passage will prove inadequate at working points. Such working points are not fixed; within limits they may occur from time to time at almost every point on the floor. In the moulding bays in particular consistently adequate light must be maintained over almost the entire floor. Thus a uniform and sufficient system of general lighting becomes essential in each and every foundry. In addition, and especially if the allowance of general lighting is not lavish, local points will be needed in certain places to augment the general system. Fettling, and the use of abrasive wheels, the machines in the fitting and patternshops, possibly the coremaker's bench, will require these local points. They must be adequately screened, the light must be properly harnessed by suitable reflectors, and they should be adjustable where possible. In assessing the intensity of light desirable, the dark matte nature of the surface worked must be borne in mind. All surfaces absorb and reflect light in varying proportions. The lighter and more polished the surface the greater the percentage of reflection. Limewashed walls lighten the foundry merely because they give back a much higher proportion of the light falling on them than does dirty and dingy brickwork. The reflection factor, or percentage of light thrown back, in the case of foundry sand is probably well under 5 per cent. Thus a given intensity in a foundry will have considerably less actual value than a far less amount in a well-designed patternshop.

In addition, absence of contrast in the colours of the foundry materials worked has a considerable bearing on the intensity of illumination desirable. It is comparatively easy to perceive white cotton and black cloth; it may be very difficult to detect even black cotton on black material. Presence and absence of contrast are respectively responsible. Since much foundry work is severely lacking in contrast, that which is available must be used to the fullest advantage. The greater the intensity of light available the greater will be the contrast, and for this reason alone generous illumination becomes necessary. The colour of the light will also be found to have some bearing on the degree of contrast obtained.

### Suitable Illumination

Suitability, the second criterion of good lighting, involves three main characteristics. There must be a reasonable degree of constancy and uniformity over the working plane, there must be complete elimination of glare, and all extraneous shadow must be eliminated. Constancy is assured by correct spacing of the general points. Each point, fitted with a modern industrial reflector, becomes the apex of an approximate cone of light. The circular base rests on the foundry floor. For the best uniformity of lighting, every point on the floor must lie within a base, there should be a minimum overlapping of the bases, and no zones of darkness should remain uncovered by either of adjacent cones. Calculation of the correct spacing is not an abstruse problem. The foot candles of floor intensity likely from a given unit at a given height will be supplied by the makers of the unit, together with the angle of light subtended. The size of the base then resulting is then a matter of elementary trigonometry. Mention should be made here of the valuable effect produced by making the ceilings as light in colour as possible, and directing on to it some of the light from the general points. This is not always a simple matter in a foundry, but it does eliminate the depressing effect of a well-lit floor overshadowed by a ceiling of darkness.

The prevention of glare should always receive attention. It may be defined broadly as "taxing the eyes with undue contrast," and is the effect

* Paper read before the London Branch of the Institute of British Foundrymen, Mr. V. Delport presiding.

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produced by introducing into the range of vision a bright surface against a relatively dark background. Where the work in hand is a part of this background there is a constant struggle between the conscious desire to regard the work and the subconscious desire to regard the intruding brighter surface. Strong light sources are by no means necessary to this effect; the sight is more hindered by a lighted match in a cinema than by many brilliant sunsets, because the contrast is far greater. Moreover, light used in producing glare is leaking light—it cannot be used in active illumination; it is thus constant waste. It may often exceed three-quarters of the total light output of the sources. The severest glare, however, is usually from local or low-set points, and it is perhaps less apparent in foundries than in most other factories.

Proper regard for shadow effect is our final criterion. For the observation of work in three dimensions, such as examining castings or cores or in wood carving in patternmaking, a degree of shadow may be found very desirable and may be artificially induced. But for normal and flat work, and in general over the foundry floor, it is best eliminated. Extraneous shadow, especially if in motion, is very distracting. Gantry cranes are commonly the cause of such fluctuating shadows in larger foundries. Complete correction is perhaps impossible, but if general points are judiciously placed under the gantry, the fluctuating shadow becomes fluctuating light intensity—the better choice of two evils.

### Systems Available

If these are now the desired standards, with what tools can one attempt to attain them? Under five broad heads there are the lighting systems in common use:—Gas lighting at mains supply pressure; gas lighting at high pressure; electric lighting by standard gas-filled bulbs; electric lighting by so-called "daylight" lamps, and electric lighting by gaseous-discharge lamps. Both systems of gas lighting give very satisfactory results. Some foundrymen assert that gas light is peculiarly and especially suited to foundry work. The high-pressure system involves the use of a pressure-raising booster, but is more economical in other ways.

Standard forms of electric lighting are common, and, provided proper fittings are used, are very satisfactory. Daylight lighting has been tried in some foundries. The unit is merely a form of light filter; of the rays emanating from the filament, it permits the passage only of those approximating to true daylight. It has the advantage that it will mix more satisfactorily with true daylight than will ordinary artificial light, but, when used exclusively, is far less cheerful than the yellower ordinary artificial light. The use of gaseous discharge lamps, particularly of the mercury-vapour type, is increasing in many large foundries. For these it has been claimed that it is easier to work by artificial light than by daylight in many buildings, and that on foggy days, when the foundry is as murky as only a foundry can be, the penetrating nature of the lighting is valuable. As an offset, the colour of the light is again rather depressing.

The automatic control of the installation in one large northern foundry may be of interest. The gaseous-discharge units are controlled through relays by photo-electric cell, in two circuits. Increasing darkness, whether due to twilight or to an overcast sky, thus automatically switches on the lighting in two stages. Incidentally, the work involves the casting of steel billets, and the uniform floor lighting so provided is 8 f.c.—a contrast to the figures previously discussed.

### Measuring Adequacy

These devices, then, are available for the better lighting of the foundry. How are they to be used? Wherever inadequacy is suspected, and for that matter even where it is not, tests of definite existing values should be made. This may be simply and rapidly done with the aid of a portable light meter. Where inadequacy is found, improvement, it is hoped, will follow. In medium and larger foundries it is undoubtedly the best policy to seek expert advice. The complete installation may be carried out by experienced lighting contractors, or where a competent staff of fitters and electricians are available, the design may be left in the hands of the expert, and the installation erected to his plans. Where the foundry is small, or a very simple system only is needed, external assistance may be quite unnecessary. Several handbooks and catalogues describe the principles of design in a series of steps. Decide, by reference, the intensity of illumination desirable for the work, select suitable types of fittings, and determine the height, location, and number of points required. Finally, determine the size of lamp necessary to provide the desired intensity.

One note of urgency must find a place in this section. The type, size and quality of the reflectors proposed should be carefully chosen and specified. To produce illumination, light must be controlled. Proper use of power, gas, electricity or steam is considered a matter for careful attention; light deserves equal treatment. A factory lighting point without its proper industrial reflector is a horse hitched to a wheelbarrow. If any excuse be needed for stressing the point with an analogy such as this, it may be mentioned that, of five hundred factories recently observed, less than 10 per cent. were equipped with suitable modern fittings. In most of the remainder, obsolete shallow conical reflectors were still in use. Yet many were of quite recent installation! They cause inevitable glare, yet make use of less than one-third to one-quarter of the light available. Such a continuing extravagance soon devours any initial saving in installation cost. To take one example, recent photometric readings in a steel-rolling mill showed that the floor illumination was increased from 4 to 6 f.c. intensity by the introduction of 150-watt modern industrial units in place of the original 300-watt points in shallow, dirty, obsolete fittings. Half the floor was at first dealt with, and the two sets of readings taken within a few minutes of each other. Fifty per cent. improved illumination for 50 per cent. less consumption was thus the result.

In a similar instance, in a spring works, by merely whitening the reflectors already fitted to a high-pressure gas installation, the available illumination was increased by 55 per cent.; by adding skirts, and so preventing glare, the increase rose to 75 per cent.

Having attained some degree of perfection, it must be maintained. Too often it is not. In such a dusty place as the foundry, adherent dust and dirt, invisible from the floor, may reduce the available illumination one-half in a few weeks. Since the dimming effect is gradual, it usually passes unnoticed. Yet personal observation has noted a foundry-floor illumination beneath a good modern fitting increase from 7 to 12 f.c. following quick dusting with a dry rag. Regular cleaning monthly, or even oftener, is the only remedy; the cost of it is, after all, negligible compared with the benefit derived. A small notebook or register is again one of the best ways of ensuring that it is done.

Works officials are strongly advised to visit the Home Office Industrial Museum in Horseferry Road. In addition to a range of exhibits showing most modern industrial safety and welfare devices, a special section is devoted to industrial lighting. The methods of applying light to many processes are demonstrated, and the advantages of good, and the evils of bad, lighting are clearly shown. In addition there is a complete range of industrial lighting fittings which may be examined and compared.

Fig. 1.—Section of Small Castings Foundry, showing Osira Lighting.

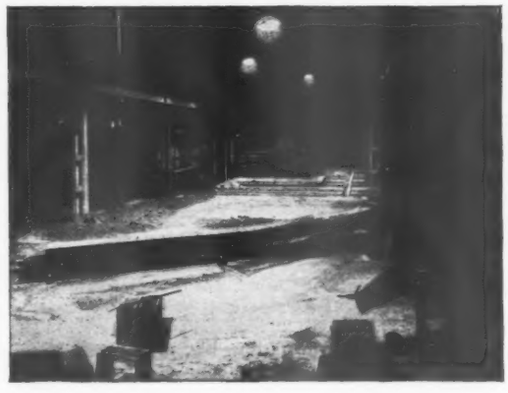

Fig. 2. — Annealing Shop, Illuminated by Osira Lamps.

*(Photos by courtesy of G.E.C.)*

### Lighting Installation Contrasted

At the conclusion of the Paper, Mr. Daniel showed some lantern slides illustrating some good and bad lighting installations in various industries, in which, of course, foundries predominated. He showed a photograph of one cutlery polishing shop in which each worker was provided with a gas bracket containing one of the old-type batswing burners. In another shop, in which a similar operation was carried out, the tables were lit by means of inverted gas mantles, there being around each burner a glass globe, the top half of which was opal. This allowed a certain amount of light to the ceiling, and, at the same time screened the eyes of the workers.

Among the more modern fittings for electric and gas lighting, he illustrated a parabolic angle reflector, which threw light at an angle. Such lighting, he said, would lend depth to a mould.

## DISCUSSION

The Chairman (Mr. V. Delport) emphasised that men could only work properly and with pleasure when the conditions were good, and good lighting was one of the conditions without which they could not work properly; it was necessary in order to prepare a mould efficiently.

Although much progress had been made during recent years, there remained many foundries, both here and abroad, in which the lighting provided was not as it should be. Apparently, the moral of Mr. Daniel's lecture was that foundries required more light than did most other shops; yet, Mr. Daniel had pointed out that in an investigation made only two or three years ago among 30 foundries, it was found that in over 50 per cent. of them the intensity of illumination at the working level was not more than 1 foot-candle, whereas the arbitrary minimum suggested by Mr. Daniel was 2 foot-candles, and from a more recent inspection among 500 factories, it was found that only 10 per cent. were equipped with modern lighting fittings. That indicated that the Paper was really required, and the members should derive great benefit from it.

### Cost of Lighting for Night Maintenance Working

Mr. A. W. G. Bagshawe (Messrs. Bagshawe and Company, Dunstable), who commented that the Paper had done him good, said that all founders were out to make a profit and it seemed that lighting was a matter in regard to which it was easy to economise in the wrong direction. He was glad Mr. Daniel had emphasised the fact—which was so easily and so often forgotten—that if one went to the trouble of cleaning the lamps occasionally the improvement in the lighting efficiency was enormous.

Where there were night shifts the average lamp consumed 10 or 12 times as much energy and cost 10 or 12 times as much to maintain in a year as it cost to maintain during the ordinary industrial hours. At his own works, when there were only perhaps 5 or 6 men working during the night, it was found that about half the total lighting over a period was used during the night hours. That indicated that economy could be effected by concentration of the work of the men engaged during the night hours.

Finally, he asked for Mr. Daniel's view as to whether, in a large works, and particularly where one had to carry out small work requiring a great deal of accuracy, sufficient illumination could be provided by a general system of illumination as distinct from concentrated local lighting.

Mr. Daniel said it was a matter of opinion as to whether or not purely general lighting was the most satisfactory in a foundry, and he would welcome expressions of opinion on that matter.

### General Lighting Preferred

Mr. A. R. Bartlett (Messrs. Fraser & Chalmers, Erith, and a Past-President of the Branch) said that in order to overcome the difficulty due to travelling cranes casting shadows when they passed below the upper lights, each crane in the foundry at Erith carried a lamp, but in addition to the upper lights, there were others attached to the columns at a height below that of the traveller. Whereas previously there were local lights which could be plugged in by individual moulders, since the new lighting system had been installed the foundry depended only on the general lighting system.

### Mercury Vapour and Headaches

Dr. A. B. Everest (Junior Vice-President of the Branch), who believed it was generally accepted that workers who had been exposed to the rays of the old mercury arc lamps had suffered headaches, said there appeared to be an impression that the new gaseous discharge lamps had a similar effect upon the men. He asked if there were any such physical effect where the gaseous discharge lamps were used.

### Inadequacy of Two Foot-Candles

Mr. J. S. Dow (secretary, Illuminating Engineering Society) said that the arbitrary minimum of 2 foot-candles intensity mentioned by Mr. Daniel seemed to be far too little for foundry work. A Committee working under the ægis of the Department of Scientific and Industrial Research had been studying the relation between illumination and the quality of work in many industries, and had found recently that even in the case of an almost purely mechanical process such as tile pressing, which was described as a process which could be carried out almost in darkness, if the intensity of illumination were less than 3 foot-candles the output and quality suffered. Foundry work, by comparison, was very skilful, and he imagined that it called for an intensity of illumination considerably higher. But, as Mr. Daniel had pointed out, there was an additional drawback in the fact that the foundry materials were of dark colour and provided very little contrast, which rendered it all the more difficult to see them clearly. He asked if Mr. Daniel considered that more contrast could be provided, and pointed out also that a higher degree of diffusion of the light by providing lighter-coloured surroundings would be very helpful. The walls and surroundings generally were being maintained in light colours in many factories where previously it had been thought to be impossible and the inactive parts of machinery were also being painted in light colours in order to reflect and diffuse the light. Proper diffusion was particularly important when observing rounded forms, because unless the light were coming from all directions one could not distinguish rounded forms easily; if the light came only from distant isolated sources one did not see the full rounded shape but only the outline.

Mr. Dow asked whether intense local lighting produced by low-voltage lamps fed from batteries had any application in foundries.

His final question was whether there was any truth in the view that in studying molten metal it was necessary to watch very carefully the change of colour as it cooled and that artificial lighting hindered one's observation of that colour change. If so, would that difficulty be overcome by the use of the electric gaseous discharge lamps, the rays from which contained very little red light?

### Daylight Gas Mantles

Mr. J. G. Clark (British Commercial Gas Association) suggested that, inasmuch as the cost of lighting in a works must represent a very small proportion of the total works costs, there should be a great incentive to the management to provide more light. The importance of analysis of costs had been emphasised by Mr. Blackwell in his Presidential Address to the Branch; Mr. Clark pointed out that if, in the analysis of costs, the lighting costs were given more consideration, it would be appreciated that, even if they were doubled or trebled, they would not make very much difference to the total running costs of the foundry. In that connection, regard must also be had to the definitely improved output that would follow from the provision of better lighting.

It might appear that Mr. Daniel had rather discouraged the lighting of the walls by the artificial illuminant, although he had pointed out the importance of limewashing the walls in order to improve the daylight illumination; but perhaps he had not wished to give that impression. Mr. Clark urged that a certain amount of brightness on the walls was helpful in the distribution of light, so creating a better general atmosphere. He did not suggest, of course, that all the light should be directed to the walls; the greater part of it should be directed to the work in progress, but the walls should not be completely deprived of illumination.

With regard to artificial lighting having the qualities of daylight, he said that as a gas engineer he had been impressed by the increasing use during the past few years of gas mantles giving a light approximating to daylight. Perhaps they had not been advertised very much, but their intrinsic qualities were such that they had been appreciated by various industries, and there seemed to be a distinct increase in their use, in preference to the ordinary mantle. The two kinds of mantle were not distinguishable one from the other by their appearance; it was purely a matter of the impregnation of the fabric. It was interesting, therefore, to note Mr. Daniel's expression of opinion that there appeared to be some advantage in using artificial daylight in preference to the more customary forms of light which were rather more red in character.

Fig. 3. — Inspection Department.

Fig. 4.—Main View of Foundry, showing Illumination by Osira Lamps. This Foundry is nearly a quarter of a mile long.

*(Photos by courtesy of G.E.C.)*

### Moulding Sand and Gaseous Discharge Lamps

Mr. R. O. Ackerley (General Electric Company), as a lighting engineer, expressed his appreciation of the Paper, and also of the prominent work in connection with lighting that was being done by the Home Office and by Mr. Daniel personally. Brief reference was made in the Paper to the intricate research that had been conducted in 500 factories, where the lighting intensities were measured and details and photographs of the installations were obtained; that must have been a colossal work, and no doubt

at some future date it would be appreciated at its real value.

The only criticism Mr. Ackerley could make with regard to the Paper was that it was rather modest in the recommendations it contained, as suggested already by Mr. Dow. However, one could appreciate Mr. Daniel's point of view.

There seemed to be a tendency, he continued, to believe that there was automatically a disability in working by artificial light as compared with natural daylight. But it had been proved that, by the use of a system of illumination in which the lights were properly placed and the reflectors were properly chosen, one could actually secure a better output by night than by day.

Discussing the merits of general and local lighting, he assumed that Mr. Daniel would agree that, except in special instances, general lighting was preferable. One reason was that it imposed less strain upon the eyes. If a man who was working under local lighting looked up from his work into the comparative gloom, his eyes immediately adapted themselves to the lower intensity, and when he looked back at his work, they had to re-adapt themselves. The period of adaptation and re-adaptation might be only fractions of seconds, but when multiplied many times in the course of a shift, the total time lost became considerable.

Referring to a diagram Mr. Daniel had drawn, to indicate that the spacing of the light sources, in conjunction with the reflectors used, should be such as to give an even distribution of light over the floor, Mr. Ackerley said it seemed to be implied that if the beams from two light sources overlapped, the result was waste. No doubt, however, Mr. Daniel would agree that the best systems of lighting were those in which the light was "built up." If a light were striking an object from one direction only, it produced deep shadows, and the object was not fully illuminated. If the light were built up from two directions, the result would be better; but if the light on the object came from half-a-dozen directions, the result would be very much better still. The interference of shadow effects due to moving cranes would also be much less where there was light built up from six directions than where there were only two lights.

Referring to some laboratory tests on the efficiency of various systems of lighting, he said that an endeavour was made to find out why the gaseous-discharge lamp was so efficient in industry, and particularly in the foundry industry. There was no question that, when one examined moulding sand under high-pressure mercury light, one could see every flaw in it far more clearly than one could under the old incandescent form of lighting. The probable reason was that moulding sand reflected the blueish end of the spectrum better than it reflected the red light, and, therefore, with a given intensity of light, the sand would show up better under the mercury light. With this type of lighting one could see better into the bottoms of deep moulds than one could when using ordinary incandescent light; that seemed to be due entirely to the fact that the high-pressure mercury lighting was reflected from the side of a mould to the bottom, so that one did not need special lighting for examining the bottom of the mould.

### The Reason for Headaches

It was true that the appearance of a human being was not at its best under high-pressure mercury light, and during the first day or two after the installation of that system there was a tendency for the workpeople to dislike it. But that dislike was overcome very quickly indeed. One of the installations illustrated by Mr. Daniel was two years old and it had been extended three times; the workmen employed there would not go back to the old system of lighting even if they had the opportunity. That applied also to other cases.

As to the physical effects, or alleged physical effects, of mercury light upon the workers, he said that the light from the old type of low-pressure mercury lamp contained an appreciable proportion of ultra-violet light; the light from the high-pressure mercury lamp had no ultra-violet light, and, indeed, no harmful light at all. At times there had been one or two complaints from workpeople who said they had suffered headaches during the first few days after the installation of high-pressure mercury lamps; but the reason was obvious. It was that the men became very interested in the new system of lighting, because the light was brighter than that afforded by the system used previously, and they would look at the lamps from time to time. Naturally, if one stared at any lamp from time to time during the day one would suffer headache. There was no physical effect on the eyes or the health of the workers, and they actually liked working under this lighting.

The Chairman said he had no doubt that another Paper could be prepared on the daytime lighting of foundries, and that improvement could be effected in that direction also. Referring to a printing-works extension he had seen recently, embodying a very well-thought-out scheme of glazing, he said the walls there were treated with aluminium paint. That had produced a rather cold effect, but he did not remember having seen any better general lighting effect than in that extension. He asked whether aluminium paint would darken more quickly than whitewash; it was certainly more expensive.

### Author's Reply

Mr. Daniel, replying to the discussion, first defended himself with regard to the much-criticised minimum intensity of two foot-candles. One way of getting a thing done, he said, was to assume a very humble standard and to prove that the standard actually achieved in many cases was far less than that. He had sought to show that an intensity of two foot-candles was a very modest minimum for any foundry, and that the lighting intensity in most modern foundries and in all those which were really well lit far exceeded that figure. He had assumed two foot-candles as an absolute minimum for the small back-street or back-alley foundry, and then had attempted to show that the intensity in a very large proportion of foundries was only one-quarter, and in some cases only one-eighth, of that figure. He had no hesitation in agreeing that an intensity of two foot-candles was a very undesirable minimum.

With regard to Mr. Bagshawe's reference to the excessive consumption of energy for lighting during the night shift, he said that naturally it was better to carry out the work of a factory during the daytime as much as possible; most people preferred to work during the day, and he believed that day work was more productive than night work. But when work had to be carried out at night, the primary consideration was to ensure that only those lights that were necessary should be used, and that they were used to their maximum efficiency.

Mr. Daniel agreed that for foundry work, general lighting was best, and it should be liberal; he did not think there was any great call for local lighting. There were cases in which hand-lamps, or cap-lamps such as those used by miners, might possibly be used, but he imagined they had not much practical application in the foundry.

Discussing the complaints made from time to time as to the effect of gaseous-discharge lamps upon human beings, he said the effect was probably psychological rather than physical. The lighting had a slightly depressing effect; but the lamps gave a very strong light of a colour very suitable for foundry work, and the increased value of the lighting could be offset against the possible psychological effect. He knew of a fettling shop illuminated by such lamps; when the lamps were installed, the shop was termed the "mortuary," and that name was still applied to it. The psychological effect of the lighting might be quite temporary, however, as had been suggested.

Mr. Daniel agreed that foundries could be much lighter than they are. Many people referred to foundries as being inevitably dirty places, and he believed that that was really the reason for much of the ill-lighting and other bad conditions. They were not necessarily dirty places, though they were dirt-creating—there was a world of difference between "dirt creation" and "dirtiness." There were many foundries in which, colloquially speaking, one would not hesitate to eat a meal on the floor; some of them were quite small foundries, the owners being the managers, and the cleanliness was astonishing. Sometimes the walls were painted and sometimes white-washed. Presumably one could hardly hope to ensure that foundries would always be able to use light-coloured sand, though it would be rather interesting to consider such a project.

He agreed with Mr. Clark that the fact that the cost of lighting was so low was probably the primary reason why some people did not bother very much about it; there were many other things which were not given much consideration because they were inexpensive. A foundry or other works was run as a profit and loss concern, and the tendency was to consider the more expensive items. If much money were being spent on power, for example, the management did everything possible to get the most out of that power; but the lighting cost, being small, was considered as a sort of inevitable annual return to be paid off as a bad debt!

A very large number of people he had met were very keen about the daylight gas mantles. The cutlers and silversmiths in particular had attributed a great deal of value to the colour of the light given by incandescent gas lamps, using the ordinary mantle; if they were introduced to the daylight form of gas mantle they might find it even better.

With regard to his reference to the positioning of lamps so that the area illuminated by one lamp did not overlap the area illuminated by the next, he said he had in mind then the very simple case of a small square floor the lighting of which was in the hands of an enthusiastic amateur. He personally would not attempt to light a foundry, having regard to his limited knowledge; it was a task for the expert, and it was false economy for others to try it. The experts would either provide an installation or they would submit designs and leave the installation to the foundry management.

### Vote of Thanks

Dr. A. B. Everest, proposing a vote of thanks to Mr. Daniel, said he believed that this was the first occasion on which the foundrymen had had a Paper on lighting presented to them, although there were about 350 foundries in London, and he imagined that the percentage which had given proper attention to lighting was very small indeed. He knew a number of foundries in which there was practically no artificial lighting.

He was wondering whether the outlook towards the lighting of foundries was the right one, for he had noted that on the lightmeter which Mr. Daniel had exhibited, foundries were included in Class B, and were classed with places for rough work, and with schools and churches. He wondered whether the minimum of 2 foot-candles would not be increased to 4 or 6 foot-candles if foundries were included, for instance, in the category of "places where an artist performed his work."

Mr. W. O'Keefe, seconding the vote of thanks, said the Paper was of great value and a great many members of the Institute would appreciate as a result that they must look more carefully at the problem of the efficient lighting of their foundries. A great many foundrymen had become accustomed to that gloomy atmosphere

(*Concluded on page* 294.)

# Non-Ferrous Casting Alloys of High Strength*

By A. J. MURPHY, M.Sc.

(*Concluded from page* 274.)

### Nickel Alloys

The strong nickel-base alloys which lend themselves most readily to casting in sand moulds are Monel metal and silicon-Monel containing approximately 65 per cent. nickel, nickel-copper-tin alloys with 40 to 50 per cent. of nickel, copper-nickel-iron alloys with 30 per cent. nickel, and the nickel-chromium and nickel-chromium-iron alloys of the "Cronite" type. In all these the strength at the ordinary temperature does not surpass that obtainable in manganese bronzes and aluminium bronzes, but their retention of strength at high temperature and their outstanding corrosion resistance frequently justify their high intrinsic cost in special applications.

Owing to the high melting point, approximately 1,350 deg. C., the melting and casting of Monel metal involve rather different procedure from the normal practice with bronze. In the author's experience melts up to 600 lbs. weight can be handled successfully in graphite crucibles in oil-fired tilting furnaces. With an efficient

Fig. 17.—Silicon-Monel Metal Valve Cage for Superheated Steam.

furnace, the pouring temperature required—1,450 to 1,550 deg. C.—is readily attained, and, in fact, it is found, rather paradoxically, that the chief danger to be guarded against is a tendency to cast at too high a temperature through over-anxiety to avoid "cold" metal.

Excessive pouring temperature can produce castings with an open, non-coherent texture, containing brightly-faceted crystals which suggest that serious contamination with carbon has occurred, although, in fact, this appearance is actually due to severe shrinkage effects. This is confirmed by the fact that such defective material, on remelting and casting at the correct temperature, gives perfectly satisfactory castings. In all cases the use of a manganese-dioxide flux and the addition of a small amount of magnesium before casting are advisable, in order to eliminate oxides and sulphides of nickel. A refractory sand, generally oil-bonded, is usually to be recommended for the moulds.

A typical composition of normal Monel metal is:—Nickel, 67; copper, 29; iron, 2; manganese, 1; silicon, 1, and carbon up to 0.2 per cent.; and sand castings show mechanical properties as follow:—Tensile strength, 24 to 34 tons per sq. in.; yield point, 14 to 18 tons per sq. in.; elongation on 2 in., 15 to 30 per cent., and Brinell hardness, 120 to 160.

The addition of silicon causes a marked improvement in the casting properties of Monel metal. Increased strength and hardness, at the expense of a loss of ductility, also result from this modification in composition, as shown by the following values:—

| | 2.5 to 3 per cent. Si. | 3.5 to 4 per cent. Si. |
|---|---|---|
| Tensile strength | 38 tons per sq. in. | 45 tons per sq. in. |
| Yield point .. | 23 tons per sq. in. | 40 tons per sq. in. |
| Elongation on 2 in. .. .. | 16 per cent. | 5 per cent. |
| Brinell hardness | 210 | 270 |

Both forms of silicon-Monel metal are amenable to heat-treatment. Heating to 900 deg. C. and quenching in water softens the alloys, which can be hardened by tempering at 600 deg. C. for 4 hrs. By this treatment a hardness as high as 370 can be attained with the higher silicon content.

Sand castings in silicon-Monel metal find application in chemical plant handling mineral acids and alkalis, in valves and nozzles exposed to superheated steam, and generally where high strength with resistance to corrosion and erosion are desired. Fig. 17 shows a valve cage which operates in superheated steam in a turbine installation.

Nickel-copper-tin alloys present a useful combination of strength, hardness, reasonable bearing properties, strength at elevated temperatures and resistance to corrosion, which make them suitable for parts of steam valves and for rubbing surfaces in pumps dealing with corrosive liquids. The alloy containing nickel 50 per cent., copper 40 per cent. and tin 10 per cent. has the following properties at various temperatures.

| Temperature of test, deg. C. | Maximum stress. Tons per sq. in. | Elongation per cent. on 2 in. |
|---|---|---|
| Room | 38.0 | 0.5 |
| 400 | 32.5 | 1.0 |
| 480 | 27.0 | 1.0 |
| 540 | 22.5 | 1.0 |
| 590 | 19.2 | 1.0 |

As in the case of Monel metal, by the addition of silicon to nickel-copper-tin alloys, it is possible to obtain a marked increase in hardness. For instance, an alloy containing 60 per cent. nickel, 28 per cent. copper and 12 per cent. tin, "as cast," has a hardness of approximately 159 Brinell. By the addition of 1 per cent. silicon this can be increased to about 190 Brinell, with 2 per cent. silicon to 260 Brinell, and with 3 per cent. silicon to 350 Brinell.

With these silicon additions, it is also possible to make a reduction in the tin content, and still retain hardness; thus, an alloy containing 67 per cent. nickel, 30 per cent. copper, and 3 per cent. tin has a hardness of about 112 Brinell. With the addition of 2 per cent. silicon, a hardness of 157 Brinell is obtained, whereas with 4 per cent. of silicon the hardness is increased to about 377 Brinell.

### Zinc Alloys

Brief reference is made to the zinc-base die-casting alloys, because they present an example of high strength and hardness in relation to the ease with which die-castings of great accuracy can be produced and the low intrinsic cost of the basic metal. The alloys of this class in use to-day represent an enormous advance on the earlier zinc alloys, which were liable to distressing failure through structural and dimensional instability, especially when exposed to moist atmospheres. The improvement which has been achieved has only been made possible by the progressive increase in the purity of the zinc obtainable, metal with a purity of 99.99 per cent. being in commercial use to-day, but metallurgical investigation has also shown that the mechanical properties of the zinc-copper-aluminium series are much superior to those of the zinc-copper-tin alloys formerly employed, although the latter still have the advantage of being more easily soldered, on account of the absence of aluminium.

In the alloys containing copper and aluminium, the presence of 0.1 per cent. magnesium is found to improve the resistance to intercrystalline corrosion, but neither the tin nor the lead content must exceed 0.01 per cent., otherwise serious brittleness results.

In alloys having as a typical composition copper 5, aluminium 4, magnesium 0.1 per cent. and zinc remainder, tensile strengths as high as 20 tons per sq. in. are obtained in die-cast test-pieces. The Brinell hardness is approximately 80, and while the elongation rarely exceeds 5 per cent., the alloys have the peculiar property of being able to undergo remarkable deformation in torsion before fracture. Since the high-speed production required in the manufacture of zinc-base die castings requires them to be ejected from the die immediately after solidification, it

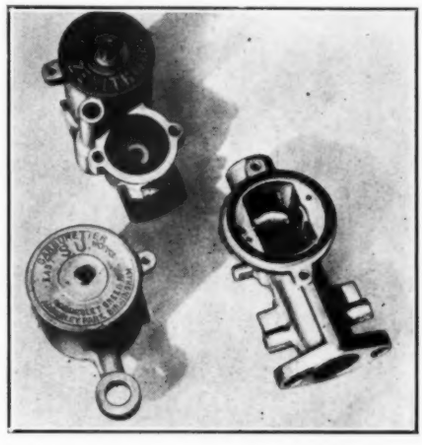

Fig. 18.—Zinc-Base Alloys, "Mazak." Die-Cast Carburettor Bodies.

is important that they should be as free as possible from hot-shortness, and the alloys of later origin are very satisfactory in this respect.

The enormous variety of applications of zinc-base die castings precludes any attempt to give a list of representative examples. Parts which illustrate their use on account of good mechanical properties are carburettor bodies, as shown in Fig. 18, parts of pneumatic chippers and even golf-club heads.

### Aluminium Alloys

The two classes of non-ferrous casting alloys remaining to be considered are the light alloys of aluminium and magnesium. In both these important series high strength, in the sense in which that term is used in the present discussion, is realised as the result of heat-treatment. The numerous publications of the last few years have provided a large amount of information on the casting, mechanical properties and applications of strong aluminium alloys. It is only proposed on the present occasion, therefore, to consider a few examples of casting alloys with which the author has been concerned recently, namely, "Y" alloy and the Ceralumin series of alloys.

"Y" alloy is of special interest because its development marked the inception of a new class of aluminium alloy, characterised by high strength and hardness, produced by heat-treatment and retained in a high degree at elevated temperatures. It represented the culmination of wartime investigations to establish an improved light alloy for the pistons of aero engines, and

Fig. 19.—Aluminium Alloy, "Y" Alloy, Sand-Cast, Heat-Treated. × 150.

the success with which this object was attained may be judged from the extensive use which it now enjoys for pistons of all types of internal-combustion engines.

The nominal composition of "Y" alloy is copper 4.0, nickel 2.0, magnesium 1.5 per cent.

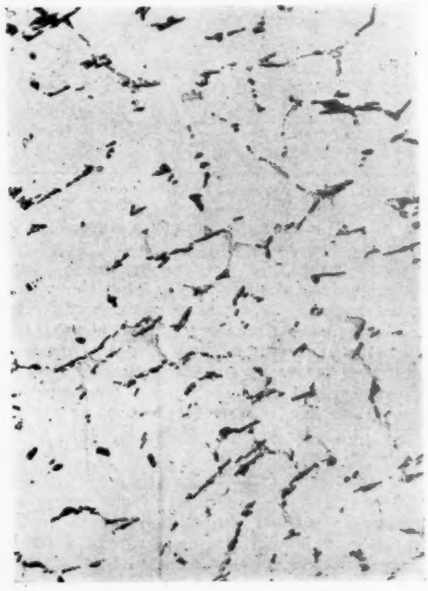

Fig. 20.—Aluminium Alloy, "Y" Alloy, Sand-Cast, Heat-Treated. × 150.

and aluminium remainder, and the specific gravity 2.8.

The heat-treatment applied to "Y" alloy consists of a "solution" stage in which the castings are heated to a temperature of 500 to 520 deg. C. for a period of 6 to 20 hrs., dependent on the section, quenched in oil, cold or hot water, and an "ageing" stage in which they are allowed to rest at the room temperature for five days.

"Y" alloy is far from being the easiest aluminium alloy to handle in the foundry. The relatively high magnesium content increases the tendency for the formation of a tenacious oxide skin on the surface of the molten metal, and this skin gives rise to dirty patches in the casting if turbulence in the mould is not avoided. A second factor which has to be contended with is the large change of volume on solidification, which calls for much more generous risers than are necessary for the simple alloys of aluminium with copper, copper and zinc, or silicon. As regards its tendency to show "pinholing" due to the release during solidification or previously absorbed gas, "Y" alloy is less troublesome than aluminium-silicon alloys, but more susceptible than, for example, aluminium-copper-zinc alloys. The very fact that the liability to these troubles is known, and that their effects are readily recognised, simplifies the task of the foundrymen in dealing with them, and it is rarely that they cannot be overcome by the systematic application of fundamental principles.

In the majority of the important castings made in "Y" alloy, permanent metal moulds or sand moulds with numerous built-in chills are employed, and it is appropriate, therefore, to consider in greatest detail the mechanical properties realised in test-bars cast in metal moulds and subsequently heat-treated. In this condition the following are typical of the properties ob-

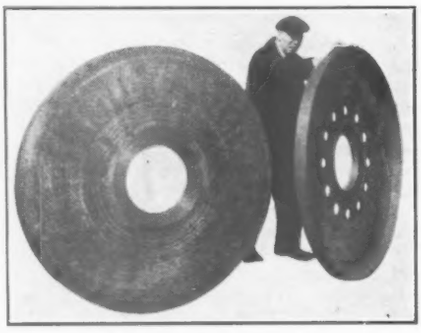

Fig. 21.—Aluminium Alloy, "Ceralumin 'B.'" Pistons for Scavenge Pump of Marine Diesel Engine.

tained:—Maximum stress, 18 to 20 tons per sq. in.; 0.1 per cent. proof stress, 14 tons per sq. in.; elongation of 2 in., 2 to 4 per cent., and Brinell hardness, 105.

In sand-cast bars of 1 in. dia., heat-treated, a maximum stress of not less than 14 tons per sq in. is required by specification L.35 for aircraft material, and a 0.1 per cent. proof stress of not less than 13 tons per sq. in. can be expected.

The strength of "Y" alloy at elevated temperatures is indicated by the following results of "short-time" tensile tests on chill-cast specimens:—

| | | |
|---|---|---|
| 100 deg. C. | .. .. .. | 20 tons per sq. in. |
| 200 " | .. .. .. | 17 " " |
| 250 " | .. .. .. | 16.5 " " |
| 300 " | .. .. .. | 16 " " |
| 350 " | .. .. .. | 12 " " |

Figs. 19 and 20 shows the microstructures of "Y" alloy in the untreated sand-cast condition, and after heat-treatment.

The Ceralumin series of aluminium alloys is derived from "Y" alloy, as will be evident from the ranges of composition shown below, the most important modifications being the deliberate addition and control of iron and silicon, which are each present in amounts up to 0.6 per cent. as "impurities" in "Y" alloy, and the presence of a small amount of cerium. The cerium performs a three-fold function, in refining the macrostructure, in modifying the form of the iron-bearing constituent in the microstructure so as to minimise its embrittling effect, and in conferring improved "running" properties on the alloy.

Two compositions of Ceralumin are in current use for sand and die castings. The first of these, Ceralumin "B," is used for intricate castings,

Fig. 22.—Aluminium Alloy, "Ceralumin 'B.'" Sand-Cast, not Heat-Treated. × 150.

the production of which calls for running properties out of the ordinary. The heat-treatment required is simple, involving only a single heating for 12 to 24 hrs. at 150 to 175 deg. C., terminated by quenching in water or oil or merely

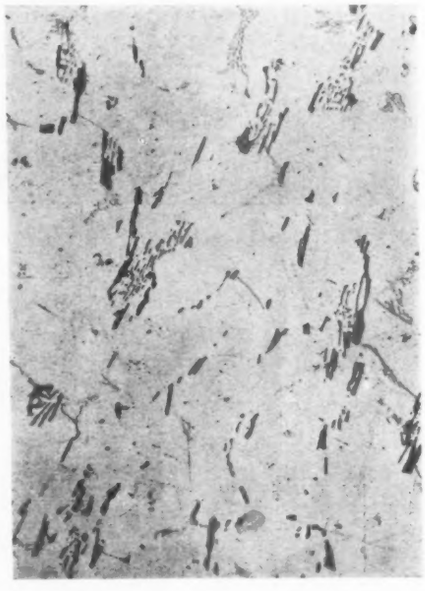

Fig. 23.—Aluminium Alloy, "Ceralumin 'B.'" Sand-Cast, Heat-Treated. × 150.

air cooling. This simple heat-treatment, and particularly the fact that it is not necessary to heat to high temperatures makes the alloy suitable for large complicated castings which it is not desirable or convenient to quench from, say, 500 deg. C. The most notable feature of the mechanical properties attained by heat-treat-

ment is the high proof stress, which confers a useful degree of rigidity without loss of ductility.

The composition of Ceralumin "B," which has a specific gravity of 2.75, is:—Copper, 1.0 to 1.75; nickel, 1.0 to 1.75; magnesium, 0.05 to 0.2; iron, 0.3 to 1.0; silicon, 0.75 to 2.5; cerium, 0.05 to 0.20 per cent., and aluminium remainder.

In a 1-in. dia. chill-cast bar the mechanical properties after heat-treatment are:—Maximum stress, 13 to 15 tons per sq. in.; 0.1 per cent. proof stress, 8 to 9.5 tons per sq. in.; elongation on 2 in., 4 to 5 per cent., and Brinell hardness, 68 to 78; and in a 1-in. dia. sand-cast bar:—Maximum stress, 10.5 to 12 tons per sq. in.; 0.1 per cent. proof stress, 7.5 to 8.5 tons per sq. in.; elongation on 2 in., 2 to 3 per cent., and Brinell hardness, 65 to 75.

Ceralumin "B" is used for the manufacture of such parts as water-cooled cylinder heads, impellers, gearboxes, crankcases, etc. Fig. 21 shows a large scavenge-pump piston for the latest type of double-acting two-stroke marine Diesel engine. Figs. 22 and 23 illustrate the microstructure of Ceralumin "B" before and after heat-treatment.

When higher strength and hardness are desired than are offered by Ceralumin "B," either Ceralumin "C" or Ceralumin "D" are used. These two latter are obtained from a single alloy (identified as Ceralumin "A") by different heat-treatments. The first stage in the heat-treatment of both is a "solution" treatment at 515 to 535 deg. C. for 6 to 20 hrs., followed by

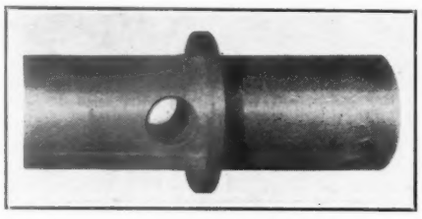

Fig. 24.—Aluminium Alloy, "Ceralumin 'D.'" Trunk for Scavenge Pump of Marine Diesel Engine.

quenching in oil or water. To produce the "C" form the castings are then tempered for 16 hrs. at 170 to 180 deg. C., and again quenched or air-cooled. The "D" form results, on the other hand, if the castings are allowed to age for 5 to 6 days at the ordinary temperature after the "solution" treatment.

The principal difference in composition between Ceralumin "C" (or "D") and Ceralumin "B" lies in the higher percentage of magnesium in the former.

| | Per cent. |
|---|---|
| Copper | 2.0 |
| Nickel | 1.0–2.0 |
| Magnesium | 0.5–1.0 |
| Iron | 1.0–1.4 |
| Silicon | 1.0–1.4 |
| Cerium | 0.05–0.2 |
| Aluminium | Remainder. |

The higher magnesium content accounts for the different response to heat-treatment, and the superior strength and hardness obtained. At the same time the higher proportion of magnesium in the alloy increases the shrinkage and makes it rather more prone to the formation of skins in sand moulds. No difficulty from this cause is encountered with metal moulds, and even in sand castings, if reasonable care is taken to ensure non-turbulent entry of the metal and to provide adequate risers, excellent results are obtained. An example of a large casting in Ceralumin "D" is shown in Fig. 24. This is the trunk to which the piston shown in Fig. 21 is attached. Typical die-castings in Ceralumin "C" and "D" are shown in Fig. 25.

The specific gravity of Ceralumin "C" is 2.79, and the mechanical properties in chill-cast 1-in. dia. test-bars are:—

| | |
|---|---|
| Maximum stress | 23–27 tons per sq. in. |
| 0.1 per cent. proof stress | 21–24 " " |
| Elongation on 2 in. | 1 per cent. |
| Brinell hardness | 130–140. |
| Fatigue strength (20,000,000 reversals) | ± 8.25 tons per sq. in. |

The high fatigue strength is particularly notable.

At higher temperatures the properties are:—

| Temperature. Deg. C. | Maximum stress. Tons per sq. in. | Elongation per cent. on 2 in. |
|---|---|---|
| 15 | 25.0 | 1.0 |
| 100 | 23.2 | 1.0 |
| 150 | 23.4 | 2.0 |
| 200 | 22.2 | 2.0 |
| 250 | 19.5 | 3.0 |
| 300 | 17.2 | 3.5 |
| 350 | 8.6 | 6.0 |

In sand-cast bars the tensile strength required by Air Ministry Specification D.T.D. 255 is:—Maximum stress, not less than 18.0 tons per sq. in., the 0.1 per cent. proof stress being not less than 17.5 tons per sq. in., and the Brinell hardness 130-140.

Ceralumin "C" is used particularly for die-castings such as pistons, where the maximum hardness and strength at ordinary and elevated temperatures are required. Figs. 26 and 27 show the change in microstructure from the "as cast" to the fully heat-treated condition of Ceralumin "C."

In many applications it is permissible to sacrifice some of the tensile strength and hardness of Ceralumin "C" in order to obtain a greater measure of ductility. An example where this consideration is important is found in air-cooled cylinder heads having deep, thin fins, which are liable to be chipped and broken if the ductility of the alloy is allowed to fall too low. Substitution of ageing for the tempering employed in Ceralumin "C" produces Ceralumin "D," having the properties, in a chill-cast 1-in. dia. bar:—

| | |
|---|---|
| Maximum stress | 19–21 tons per sq. in. |
| 0.1 per cent. proof stress | 11–13 " " |
| Elongation on 2 in. | 4–6 per cent. |
| Brinell hardness | 98–104. |

Air Ministry Specification D.T.D. 250, governing Ceralumin "D" castings, requires a maximum stress of not less than 14 tons per sq. in. in a sand-cast test-bar, the 0.1 per cent. proof stress of which is not less than 11.5 tons per sq. in., elongation in 2 in. 1-3 per cent., and Brinell hardness 98-104. Fig. 25 shows a series of die-castings in Ceralumin "C" and Ceralumin "D."

From the data given above it may be seen that Ceralumin "C" has a higher strength and hardness than "Y" alloy in its normally heat-treated condition, while Ceralumin "D" with approximately the same tensile strength and hardness as "Y" alloy has the advantage of a higher elongation.

### Magnesium Alloys

In relation to their low specific gravity—in the order of 1.80 to 1.82—the alloys of magnesium could be described justifiably as of high strength, even in the normal cast condition without heat-treatment, since in this form tensile strengths of 9 to 12 tons per sq. in. in sand castings, and 10 to 15 tons per sq. in. in chill castings, can be obtained without difficulty. On the strength of such properties as these Elektron castings find a steadily increasing range of application. The two casting alloys in most general use, which are known as Elektron "A.8," and Elektron "A.Z.91," have the approximate compositions:—

| | Elektron "A. 8." | Elektron "A.Z. 91." |
|---|---|---|
| | Per cent. | Per cent. |
| Aluminium | 8.0 | 10.0 |
| Zinc | 1.5 | 1.0 |
| Manganese | 0.3 | 0.3 |
| Magnesium | Remainder | Remainder. |

In the normal cast condition the mechanical properties are:—

| | Elektron "A. 8." | | Elektron "A.Z. 91." | |
|---|---|---|---|---|
| | Chill cast. | Sand cast. | Chill cast. | Sand cast. |
| Maximum stress, tons per sq. in. | 13–15 | 9–11 | 11–14 | 8–11 |
| 0.1 per cent. proof stress, tons per sq. in. | 4.5–5.5 | 4–5 | 5–5 | 5–6 |
| Elongation per cent. on 2 in. | 6–10 | 3–5 | 4–8 | 2–4 |
| Brinell hardness | 50–60 | 45–55 | 65–70 | 60–65 |

The diminishing solid solubility of aluminium in magnesium with fall in temperature would suggest that the magnesium-rich alloys containing aluminium should respond to a double heat-treatment in the same way as the light alloys of aluminium with copper, resulting in an in-

Fig. 25.—Aluminium Alloy, "Ceralumin 'C' and Ceralumin 'D'" Die-Casting.

crease of tensile strength, proof stress and hardness as compared with the "as-cast" condition. This is what actually occurs in the alloy Elektron "A.Z.91": A "solution" treatment at a temperature close to that of the eutectic produces a marked increase in the tensile strength and elongation, while the proof stress and hardness are not affected. When castings are tempered at 150 to 200 deg. C. following the solution treatment, the proof stress and hardness are raised to an extent depending on the precise time and temperature of the final treatment. In Elektron "A.8," with lower aluminium content, the response to the "solution" heat-treatment is similar to that of "A.Z.91," but subsequent tempering has little effect on the proof stress and hardness.

The range of mechanical properties obtained by complete heat-treatment of the two alloys mentioned is approximately as follows:—

| | Elektron "A. 8." | | Elektron "A.Z. 91." | |
|---|---|---|---|---|
| | Chill cast. | Sand cast. | Chill cast. | Sand cast. |
| Maximum stress, tons per sq. in. | 15–18 | 15–17 | 17–20 | 15–18 |
| 0.1 per cent. proof stress, tons per sq. in. | 4.5–5.5 | 4.5–5.5 | 8.5–9.5 | 7–9 |
| Elongation per cent. on 2 in. | 12–17 | 10–15 | 3–5 | 2–4 |
| Brinell hardness | 50–60 | 50–60 | 70–80 | 70–80 |

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It will be seen that the tensile strength of these heat-treated magnesium alloys is comparable with that of the stronger aluminium alloys, such as "Y" alloy, although the specific gravity is 40 per cent. less. This is a very remarkable achievement, which cannot fail to be of interest to the aircraft and other transport industries, and generally where stressed components, reci-

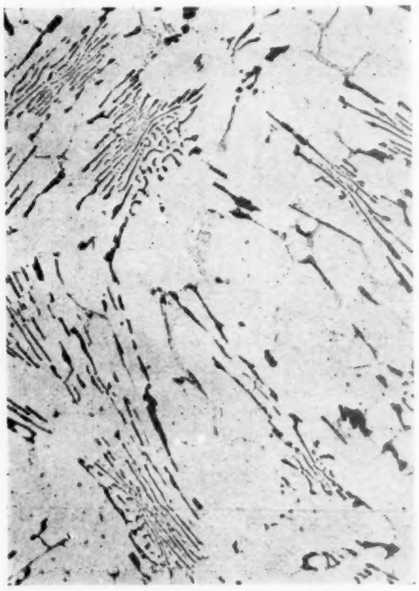


Fig. 26.—Aluminium Alloy, "Ceralumin 'A,'" Sand-Cast, not Heat-Treated. × 150.

procating at high speeds, are in use. The alloy containing 10 per cent. of aluminium has a special claim to notice on account of the useful increase in proof stress which results from heat-treatment. This makes possible the use of Elektron in applications where it has not previously been suitable because of the relatively low proof stress in the normal cast condition. Heat-treated Elektron "A.8," does not show a similar advantage, but, on the other hand, the high-tensile strength and elongation suggest that it may be of special interest for parts in which stress concentration effects are liable to be encountered.

The application of heat-treated Elektron castings is only in its infancy, but its further extension can be anticipated with confidence as it becomes realised in which directions the improved properties justify the additional expense of heat-treatment. Already the advantages of heat-treatment have been confirmed for such parts as crankcases similar to that shown in Fig. 28, instrument brackets, and large reciprocating air valves in marine engines.

### Specific Tenacity

It has been mentioned in several places in the foregoing account how the term "high strength" may be related to various other properties, such as corrosion resistance, casting properties, and to economic considerations. It is probable, however, that the most important basis of comparison is found in the specific gravity of the various materials. The expression "specific tenacity" has been used to indicate the relations between engineering materials in this respect, and it may be interesting to classify from this aspect the non-ferrous casting alloys which have been discussed. Expressing "specific tenacity" as $\frac{\text{Tensile strength in tons per sq. in.,}}{\text{Specific gravity}}$ the various materials fall into the series shown in Table VI.

The alloys might be compared in a similar manner by tabulating the quotient of $\frac{\text{Proof stress}}{\text{Specific gravity}}$, and so on, but the list given is sufficient to indicate the information available for the designer working under certain limitations of weight. From this aspect the metallurgy of light metals has advanced to the point where the heat-treated alloys of aluminium and of magnesium can offer the means of actually increasing the strength of a casting of almost any other material, ferrous or non-ferrous, while at the same time effecting a substantial economy in weight.

Other considerations, which have been mentioned previously, decide the choice of material for castings in favour of other non-ferrous alloys. It has been the author's endeavour to show in outline the fields in engineering practice for

Table VI.

| | Tensile strength. | Specific gravity. | Specific tenacity. |
|---|---|---|---|
| *Copper-base alloys.* | | | |
| Manganese bronze: | | | |
| Alpha - Beta (sand cast) .. .. | 40 | 8.1 | 4.9 |
| Beta (sand cast) .. | 50 | 8.0 | 6.2 |
| Aluminium bronze (sand cast) .. .. | 45 | 7.5 | 6.0 |
| *Nickel-base alloys.* | | | |
| Monel metal (sand cast) | 30 | 8.8 | 3.4 |
| Silicon-Monel metal metal (sand cast) .. | 40 | 8.8 | 4.5 |
| *Zinc-base alloys.* | | | |
| Zinc–aluminium–copper–magnesium (chill cast) .. .. .. | 20 | 6.7 | 3.0 |
| *Aluminium-base alloys (heat-treated).* | | | |
| "Y" alloy (chill cast) | 20 | 2.8 | 7.1 |
| Ceralumin "B" (chill cast) .. .. .. | 15 | 2.75 | 5.5 |
| Ceralumin "C" (chill cast) .. .. .. | 25 | 2.8 | 8.9 |
| Ceralumin "D" (chill cast) .. .. .. | 20 | 2.8 | 7.1 |
| *Magnesium-base alloys (heat-treated).* | | | |
| Elektron "A. 8" (chill cast) .. .. .. | 17 | 1.8 | 9.4 |
| Elektron "A.Z. 91" (chill cast) .. .. | 19 | 1.8 | 10.6 |

which each of the strong non-ferrous casting alloys is best suited, and in which it has often gained and retained its position in the face of increasing competition from cast iron or steel, or from wrought ferrous and non-ferrous materials. The indispensable requirement for extending the application of non-ferrous casting alloys of high strength is increased confidence

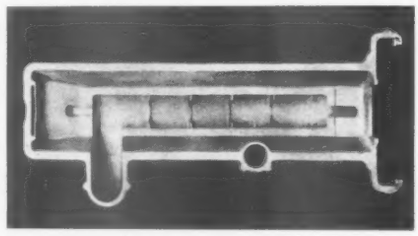


Fig. 28.—Magnesium Alloy, "Elektron 'A.Z.91'" Crank-Case.

on the part of the engineer in the consistency and reliability of the castings produced. In nearly every case the full advantage of these special alloys is only gained at the expense of unremitting care, and often special technique, in the foundry; in these circumstances there can be no doubt as to the vital part which the foundryman plays in translating into consistently successful practice the results of research and development in physical metallurgy.

In collecting the data and illustrations for this Paper, the author has drawn chiefly upon examples from the laboratory and foundries of J. Stone & Company, Limited, Deptford, and his thanks are due to the directors of that company for permission to publish the various par-

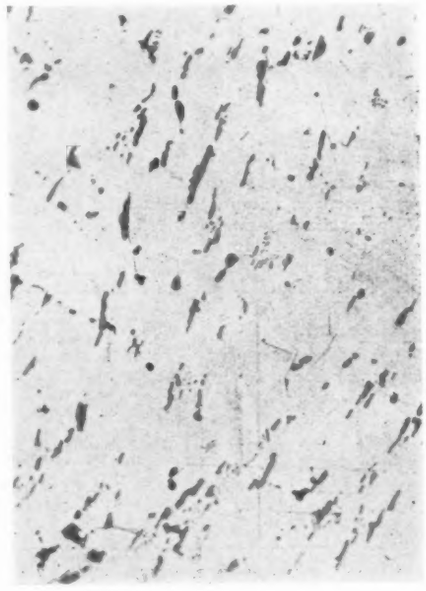


Fig. 27.—Aluminium Alloy, "Ceralumin 'C,'" Sand-Cast, Heat-Treated. × 150.

ticulars and photographs. Messrs. Richardson, Westgarth, Limited, kindly gave permission to reproduce in Figs. 21 and 24 photographs of large Ceralumin castings made for the latest R.W. double-acting two-stroke marine oil engine. The author also acknowledges with pleasure assistance in the form of further information from Mr. J. McNeil, of the Mond Nickel Company, Limited (who supplied the photograph in Fig. 17), from National Alloys, Limited (by whom Fig. 18 was supplied), and from Fry's Metal Foundry, Limited. To his colleagues, Messrs. G. T. Callis, B.Sc.Tech., S. A. E. Wells and J. P. Ellis, the author's special thanks are due for much assistance in carrying out tests and preparing photographs.

## Lighting in Foundries

(*Concluded from page* 290.)

created by the settling of dust, but if they had considered it when their buildings were being designed they might have been able to eliminate some of the structural features which carried a lot of dust. Further, in many cases white tiles might be used with great advantage; they could be cleaned down readily during the week-ends, so that they always presented a surface which would reflect the light, whether it be natural or artificial.

Finally, Mr. O'Keefe urged that industrialists and the public generally might with great advantage visit the Home Office Industrial Museum in Horseferry Road, Westminster; the Home Office had taken the trouble to provide such facilities for the study of lighting and other industrial problems, and it was up to those whom it was intended to benefit to take advantage of it.

The vote of thanks was carried with acclamation.

Mr. Daniel, in the course of a brief response, said the Home Office Industrial Museum was open to the public daily between 9 a.m. and 5 p.m.

XUM

# The Manufacture of Piston Rings

## CASTING AND HEAT-TREATMENT

By JEAN CHALLANSONNET (Engineer of the National Institution of Arts and Crafts, Paris)

[Abridged Translation.]

### Introduction

The chambers of heat engines should be absolutely tight to ensure that they function properly. To this end, the normally concentric rings, known as piston rings, which are fitted on the periphery of the piston should, with the help of a lubricant, prevent as far as is mechanically possible, all lack of contact between that part and the cylinder lining.

The rings should allow the piston to slide freely in the cylinder at all loads. They are fitted in a large variety of engines, cylinders using saturated steam, superheated steam, air-compressors, large and small gas-engines, automobile engines of all capacities, diesel and semi-diesel engines, etc.

This diversity of conditions of functioning indicates the complexity of the problem, which consists of obtaining a piston ring adapted to its duty. One and the same foundry is obliged sometimes to adjust its types of metal and its casting processes in order to obtain, on the one hand, rings of which the diameter is of the order of ten centimetres and the thickness a few millimetres, and on the other hand, rings ten times as large.

One can easily imagine that wear and tear results from the friction due to the continuous sliding to and fro of the piston rings in the cylinder, on one or the other. A study of mechanics gives the following information as to sliding friction:—

Taking a test-piece of a metal A, having a well-machined surface S. Place this on another machined surface of a metal B, and let N be the normal pressure between the two surfaces. In order to displace A in a vertical direction to N, in other words, to make it slide, it must be submitted to a force $\psi$ equal to $f$ or the force of friction. The ratio between $f$ and N determines the coefficient of friction K.

K varies greatly with the nature, the structure, the degree of polish, the temperature and the lubrication of the surfaces, etc. Two metals of the same kind rubbed together when dry have a coefficient of about 0.2; with lubrication this may be reduced to 0.05 or even 0.01.

According to the investigations of Fichter, the coefficient of friction varies in a very curious way with the degree of polish of the surfaces. If the perfection of the polish is gradually increased, the coefficient of friction commences to diminish, reaches a minimum for a critical polish and then increases very rapidly when a mirror-like polish is approached. There is then a phenomenon of molecular adhesion similar to that which is observed with the Johanson tables. The minimum coefficient of friction of 0.001 is obtained when there is a continuous film of oil between the two surfaces; nevertheless, the English physicist Mallock has recently shown that in the friction between two bodies of largely differing hardness subjected to high pressures the presence of the lubricant results in an increase in the coefficient of friction instead of a decrease. Finally, it must be remembered that the force of friction is independent of the area of the surfaces, and it must not be forgotten that there is a critical pressure at which the force of friction increases considerably; the surfaces heat up and abrasion takes place, causing seizing. It must be remembered also that the critical pressure of seizing in the dry condition for two grey castings of the same hardness is in the neighbourhood of 10 kgs. per cm.$^2$ with a coefficient of friction of the order of 0.3.

### Wear

Owing to the large number of factors which condition it, wear is one of the most complex of problems which the physicists and metallurgists have to solve. Very frequently in the problems of wear which are set by mechanical construction, particularly the construction of internal-combustion engines, there is something else besides ordinary abrasion.

The conclusions drawn from many tests of a practical nature on friction, up to the present, whether on cast irons or on steels, have not yet been able to be established on a scientific basis, because of the minute care required in these investigations so that not more than one factor should vary at a time.

Wear is obviously connected with the work done by friction, but also depends on the chemical composition of the alloys, their hardness, their micrographic structure, their original degree of polish, on the mode of elimination of the products of abrasion; on the lubrication; the temperature and its variations from time to time, etc. The Japanese physicist, Masukino Suzuki, has recently indicated many new points on the mechanism of the wear of steels.

The point in question relates to two samples of steel which were subjected to friction by sliding:—(1) If the two samples have the same carbon content and the same structure, the total wear and tear varies in accordance with the square of the coefficient of friction, and (2) in the case of rolled or annealed structures having a constant coefficient of friction, the wear of the active sample A increased with increased carbon content; the rate of this increase diminished in the higher carbon regions (0.8 per cent.).

At the same time the wear of the passive sample B having a fixed percentage of carbon increased at first, then decreased with a certain rapidity which diminished for the high carbon contents of the active sample. It follows that the more the carbon content of the samples differ from one another, the more their wear is dissimilar.

The author has also studied the influence of heat-treatment. If each of the samples has a troostitic, sorbitic or martensitic structure with the same carbon, the total wear does not vary when the carbon is altered. It varies only with the coefficient of friction.

In 1928 Piwowarski, studying rolling and sliding friction between two samples of the same pearlitic metal, recorded that the wear expressed in loss of weight, decreased when the phosphorus was increased, at any rate between 0.1 and 0.8 per cent. Does it follow that a large content of phosphorus is advisable for piston rings? If extreme brittleness and machining difficulties did not result, this course would very soon be adopted, because it would tend to diminish costs and to increase the ease of casting, which latter point is of particular interest to producers of separately-cast piston-rings.

According to Klingenstein, by increasing the percentage of phosphorus from 0.1 to 0.7 per cent., the resistance of "ferritic" grades to wear is doubled. The improvement in the pearlitic irons would be clearly less apparent, even on increasing the phosphorus content to 1.4 per cent. The same author has recorded that iron grades containing coarse graphite give better results than those with fine graphite.

Other experimentalists affirm, on the other hand, that eutectic graphite or graphite in the form of small nodules is to be preferred. Speaking generally, the interpretation of laboratory tests relating to wear is always difficult, and direct application of the results to actual practice is not feasible.

The wear on piston-rings, the optimists explain, is necessarily greater than that on the cylinder; in fact, the rings are subjected to a much greater amount of friction per unit of surface. It is even contended that, *ipso facto*, the question of matching the piston-ring metal with that of the cylinder is quite a secondary matter. The question, however, is far from being so simple, because the friction-resisting properties of the piston-ring and of the cylinder, and the degree of lubrication efficiency, are not the sole causes of wear. For instance, the lateral reaction of the connecting-rod causes rocking of the piston—the head of which has just slid against the cylinder wall, thus gradually wearing the cylinder above the extreme travel of the top piston-ring. Finally, abnormal wear and tear is frequently caused by piston-ring breakages, by excessive expansion of the piston, or by faulty connecting-rod design.

Many technicians attach great importance to the pressure of the piston-ring on the cylinder, such as is determined by elasticity. There is, however, another point to be considered, *i.e.*, the pressure due to the compression of the gases behind the top ring is generally higher than imagined. When making experiments with a diesel engine, the British engineer, Shannon, observed that the pressure behind the first piston-ring rose to three-quarters of the pressure in the cylinder. This author estimates that the pressure resulting from "elasticity" is negligible as compared with the pressure exerted by the gases in the groove. This consideration no doubt suffices partly to explain why top piston-rings wear more rapidly than the others. In order to remedy this, various investigators in addition to Shannon, have proposed, particularly for the diesel engine, to employ a double piston-ring so as to prevent increase of the pressure in the groove.

### Shape of Piston Rings

The piston-rings of internal combustion engines are usually of rectangular section. The dimensions of piston-rings intended for bores not exceeding 120 mm. have been fixed by the "Bureau International de Normalisation de l'Automobile" (B.I.N.A.).

The piston ring having been inserted by a suitable process, the two ends at the joint are brought together, and the piston ring is machined on the lathe in accordance with the diameter of the cylinder. Thus the piston ring adapts itself to the liner with a force which corresponds to the elastic compulsion necessary for bringing the two ends together at the joint.

### Splitting the Piston Rings

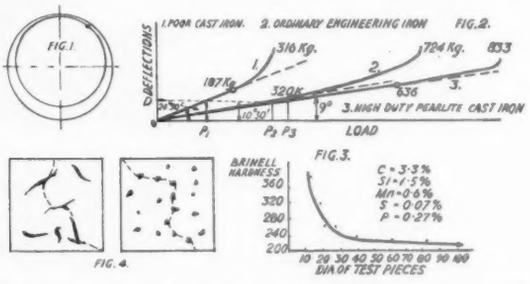
Piston rings for motor-car engines have generally an obliquely-cut joint. The joint standardised by the "B.I.N.A." is inclined to the left, that is to say, that the acute angle formed by a diameter and the joint has its apex on the left of the observer, looking at the edge of the piston ring. A Z-shaped joint is used for scraper rings.

### "Springing" of the Piston Rings

The "spring" of the piston rings is the controlling force tending to adapt the face of the open ring to the interior wall of the cylinder. The spring of small piston rings is obtained by a process involving tempering. The process at present used for springing large piston rings made of cast iron necessitates particularly skilful treatment. Another method was formerly employed. The rings were machined from eccentric

blanks rough from the foundry. When the thick part had been split, the ring had a tendency to open under the influence of internal-casting stresses (Fig. 1). The ring was finished on the lathe to the diameter of the cylinder after bringing the ends together at the joint.

Since the investigations of Le Thomas[1] have indicated the mechanism of the neutralisation of the internal stresses of cast iron for engineering castings, the irrational nature of this method is thrown into relief. In the experiments carried out by this experimentalist, the internal stresses of the ring were augmented by the use of a refrigerator, which had the effect of accelerating the rate of cooling of the thin portion. After cutting through the thick part with the saw the ends opened feebly. But the important fact which arises from this is that the internal stresses are already greatly reduced by prolonged heating at 300 deg. C. It is certain, therefore, that a piston ring of this kind, if fitted into an engine working at very high temperatures, would be found in the long run to have lost a great deal of the springing efficiency it owed to casting internal stresses. This view has been confirmed in actual practice. Moreover, a ring prepared as above will always be characterised by serious structural and mechanical heterogeneity. On the other hand, as indicated in a Paper contributed by Le Thomas to the Académie des Sciences, certain internal-casting stresses may happen to be localised on the surface, and slight grinding may accordingly suffice considerably to reduce the opening at the joint. Apart from making the piston ring unreliable in operation, the method is one that also involved much uncertainty as regards manufacture.




### Springing of Large Piston Rings

In the case of pistons of large diameter, the springing capacity of the piston ring itself is generally insufficient for ensuring adequate peripheral tightness, and a spring is fitted between the piston and the ring. Plate-springs are generally used, but spiral springs or metal foil have also been employed.

### Methods of Casting

Before considering the characteristics of cast iron to be used for the manufacture of piston rings, it should be remembered that foundries which specialise in these products employ two methods which differ considerably. (1) According to one method the rings are machined from cast cylinders or "blanks" and (2) according to the other, rings are cast individually and subsequently finished to size by suitable machining. It is obvious that the second method is such as to ensure a large machine-shop output.

### Separately-Cast Piston Rings

The technique of casting piston rings of small dimensions (*e.g.*, 72 mm. dia., 2.5 to 3 mm. thickness) on quantity-production lines is most exacting. It is necessary to obtain piston rings which are absolutely free from defects, such as porosity or blow-holes, which might cause breakage when fitting or during operation. Structural faults must also be avoided, such as free carbide of iron or steadite, which constituents offer machining difficulties and shorten the life of piston rings on account of brittleness.

Each of the above-mentioned methods involves an entirely distinct foundry problem. In the one case, the rate of cooling after casting is very rapid; in the other, it can be described as intermediate. Be that as it may, the process of separately-cast piston rings, promoting large outputs, is now much preferred.

In 1931, the Perfect Circle Company in six months' time produced nearly 30,000,000 separately-cast piston rings in their foundry at Newcastle (Ind.), with, it is said, foundry rejections representing less than 5 per cent. of the total output.

### Qualities of Cast Iron for Piston Rings

The question must at once be asked: Is the choice of the cast iron to be determined by well-defined tests effected in actual operation, or is it to be imposed by the method of casting adopted in view of the quality or of the output? Scientific investigation of wear and tear is not yet sufficiently advanced to enable the postulation of any definite doctrine such as would make it possible to foresee how wear will occur in such a complex case as that of heat engines.

Investigating the problem as a whole, Le Thomas has defined the qualities of a cast iron specially adapted to the manufacture of piston rings.[2] These characteristics are:—(1) A large capacity for elastic distortion, (2) high-springing efficiency during the period of elasticity, (3) correlatively, a high-breaking "load" and better resilience, (4) permanency of these qualities, in spite of the influence of varying temperatures and stresses, (5) a well-defined Brinell hardness and (6) a structure free from microscopic hard spots, such as cementite, phosphorus eutectic and manganese sulphide.

In order to obtain these properties in practice, the author states definitely that it is necessary to adopt a pearlitic iron. He indicates, *inter alia*, that slight distortion of the piston ring (opening of the joint) should give it good springing efficiency. He shows, in effect, by means of Frémont's transverse-strength diagram, that the stronger the metal the greater the springing efficiency for any given deflection.

Fig. 2 shows typical diagrams of Frémont's transverse tests[3] with cast irons of very different qualities. (The modulus of elasticity increases when the slope of the curve in relation to the horizonal decreases.)

### Modulus of Elasticity

Piston rings should have a high limit of elasticity in order not to snap or to show permanent distortion at the time of fitting on to the piston. To sum up, the manufacture of piston rings raises the following problems:—(1) The attainment of a hardness and structure conditioned by the two corresponding characteristics of the cylinder; (2) the obtaining of maximum resilience compatible with the other qualities, and (3) the attainment of a high modulus of elasticity, of which the corollary is a good springing efficiency for a small amount of distortion. The modulus of elasticity is regarded more and more as the best criterion of the quality of cast irons for engineering castings. Moreover, as stated by Frémont, the coefficient of elasticity of the metal increases when the resistance to transverse loading increases; this is an additional reason for using cast iron, the high strength of which is indicated by a transverse test.

Finally, these qualities should be maintained notwithstanding the effect of temperature, which may be, particularly in the Diesel engine, very considerable. It is, therefore, necessary to produce cast irons of high stability in the presence of heat, and whose low tendency to graphitisation at moderate temperatures shall have been ascertained by means of prolonged tests.

Below are tabulated the principal methods adopted or which can be employed:—

| | |
|---|---|
| Machining of piston rings from "blanks" cast from: | Ordinary grey cast iron.<br>Phosphoric cast irons.<br>Pearlitic cast iron.<br>Pearlitic cast iron with small quantities of special elements (Ni and Cr, Mo and V).<br>White cast iron graphitised by heat-treatment. |
| Separately cast piston rings made from: | Grey cast iron.<br>Pearlitic cast iron.<br>Troosto-sorbitic cast iron with special elements (Ni, Cr, V, Mo).<br>White cast iron with graphitising heat-treatment.<br>Martensitic cast iron (Ni, Ni-Cr). |

### Production

It is necessary to distinguish between the heat-treatment employed to obtain the spring and that where heat-treatment or treatments are intended to modify the structure before machining—generally graphitising, annealing or a process of tempering.

When one wishes to dispense with all these treatments, the method for piston-ring blanks offers greater latitude than the process of individual rings. In this way the production with ordinary grey cast iron and pearlitic pig-iron is relatively easy. For instance, the analysis: C, 3.20; Si, 1.80; Mn, 0.60; S, 0.08, and P, 0.40 per cent., gives blanks with a hardness of about 240 Brinell if the diameter is of the order of 10 cm. and the thickness 5 to 6 mm. The addition of special elements, such as nickel, chromium, vanadium or molybdenum, singly or in association, enhances the mechanical properties. The scope of this article does not permit the examination in detail of the action of the elements on irons used as thin castings.

A material of the following variety prepared from a virgin iron containing vanadium (0.15 per cent. in the charge) and titanium is interesting for the production of piston rings from blanks, because of its high transverse resilience limit and its relatively average hardness:—T.C., 2.48; C.C., 0.62; Si, 2.82; Mn, 0.43; S, 0.022; P, 0.050; V, 0.15; and Ti, 0.038 per cent. Brinell hardness, 235 (cast in dry sand); C.R. transverse, 72.7 kg. per sq. mm.; L.E., 800-kg. cylindrical test-piece; dia. = 28.6 mm.; distance between centres, 600 mm. In spite of its high limit of elasticity, this silico-vanadium iron presents a large permanent transverse strength, since its deflection is 18 mm.

### Separately Cast Piston Rings

If one wishes to dispense with all heat-treatment after casting, the range of chemical compositions available will be found particularly restricted. It is definitely a question of casting, in the case of standard piston rings for motor-car engines, rings whose section is as small as 3 mm. by 3 mm. On referring to a curve (Fig. 3), due to M. Le Thomas (4) showing—in relation to the diameter—the hardness of bars made with an iron having a pearlitic structure of great thickness, it is seen that for bars less than 20 mm. in dia., the hardness increases considerably and rapidly exceeds 350 Brinell, with a high carbide or iron content. Such a composition should therefore be rejected for small separately-cast piston rings. In order to obviate the chill of white iron and the great difficulties thereby involved in respect to machining, the chemical factors of graphitisation are especially important, and the following analysis is thus postulated:—C, 3.6; Si, 3.0; Mn, 0.5; and P, 0.3 per cent.

Thus there is obtained a common grade of grey iron, almost entirely ferritic, the hardness of which never exceeds 180 Brinell. This process, synonymous with high yield and little trouble, never produces anything better than grey irons of average mechanical quality if the use of special elements and heat-treatments, graphitising annealing, martensitic hardening and tempering are rejected.

This very simple foundry process gives, under quantity production conditions, piston rings in bunches. The main feeding head feeds a central runner, which, in turn, feeds a circular rim of fairly considerable diameter, and this rim is capable of feeding 7 or 8 rings situated in the same plane. Thus 12 different planes are dealt with. One "bunch" gives about one hundred piston rings. Each ring comprises a small bob or blind riser diametrically opposite the main down gate.

### Structures Encountered in Practice

Micrographic examination can frequently show the method of manufacture. Piston rings made from "blanks" which are not treated contain a flaky coarse graphite; the single-cast piston rings, a graphite generally in the form of much smaller division. This fine graphite is the result of the quick rate of cooling.

Superheating of the iron, generally resorted to for the purpose of increasing the fluidity, further contributes to the refinement of the graphite, which sometimes assumes the eutectic condition. This arrangement of the graphite is extremely interesting, in the sense that it diminishes the risks of fracture when fitting and even when under power. As will be gathered from Fig. 4, any incipient fracture will progress more easily in an iron with long graphite flakes than in a piston ring where nodular graphite nuclei are widely dispersed. Piston rings cast with white-iron and graphitised by annealing are also in this respect an excellent solution, because the temper carbon is generally in the form of small nodules. Any graphitisation treatment, which is excessive and therefore liable to produce ferrite only, should, however, be avoided, because the modulus of elasticity of the casting would be too low and the piston ring would be liable to great distortion when subjected to small stresses.

Phosphorus eutectic is—with the same percentage of phosphorus—more largely developed in piston rings machined from "blanks" than in separately-cast rings, this being due to the rapidity of cooling. In the first case it produces zones of brittleness which shorten the life of the piston ring.

### Defects

*Physical defects.*—Microscopic piping, faults due to the bad arrangement of the moulds, vents, or the introduction of slag which remains adhering to the core.

*Chemical defects.*—Nests of graphite, *i.e.*, a segregation of the free carbon in a "widish" zone which may attain a diameter of several millimetres. Such defects are met with particularly in separately-cast piston rings having a high carbon content, the section being considerably weakened thereby.

*White-iron chill.*—These defects are local or general, and such chilling frequently affects the whole of the peripheral bearing. This condition is due to bad adjustment of the factors responsible for primary graphitisation (chemical composition, sand moisture, etc.), or, finally, to all the faults that may be encountered in irons used for engineering castings, phosphoric spots, manganese-sulphide crystals, etc.

### Heat-Treatment for Springing

The methods used for springing piston rings fall into two distinct classes:—(1) The ring is cast in such a form that after splitting it and bringing the ends together it may be a perfect circle. Springing efficiency will then be dependent upon the ratio between the width of the joint and the sides of the piston ring, and on the mechanical characteristics of the casting obtained. This method demands great accuracy in moulding. It is applied with difficulty to the production of piston rings machined from cylindrical castings.

(2) The ring is cast in the form of a perfect circle and then split. The ends are forced apart elastically to a definite distance and then set in that position by heat-treatment (effect of the internal stresses). The piston ring is closed again and its peripheral surface is rectified in order to produce a perfect circle.

### Some Experiments on Piston Ring Tensions

Considering a cast ring (Outside dia. = 65 mm. – inside dia. = 46 mm. – gap = 2.5 mm.) in the rough state (T.C. 3.6, Si 3.0, Mn 0.5, P 0.3, and V 0.2 per cent.), and noting that the internal casting stresses are sufficient to separate the ends at the joint, if this same ring be oil-hardened at 875 deg. C. the ends at the joint separate to the extent of 1.2 mm., and the piston ring takes a "spring" of 650 gr. The Brinell hardness increases from 180 to 450, and annealing at 500 deg. reduces this to 200 without the gap at the joint being appreciably altered.

For piston rings of the above dimensions a pressure of 0.2 to 0.5 kg. per sq. cm. is generally admitted. The pressure obtained by the so-called "tension" process is accordingly insufficient. In practice the gap is forced apart elastically; the rings being then fixed on a special peg and hardened at about 800 deg. About one hundred rings are thus treated at a time.

In the case considered here, the relatively large silicon content does not permit of complete martensitic hardening. Annealing at a moderate temperature decreases the hardness and weakens the "tensions" without appreciably diminishing the amount of spring. This process of adjusting the tension by bringing the ends apart in the cold state frequently causes microscopic fractures, which become enlarged and lead to breakage in operation.

The metallurgical part of the investigations were carried out in the laboratory of the chair of Metallurgy of the Conservatoire National des Arts et Métiers de Paris. The author is indebted to Professor Leon Guillet, member of the Académie des Sciences and to Professor Jean Cournot, lecturer at the Ecole Polytechnique.

BIBLIOGRAPHY.

1 A. Le Thomas. "La suppression des tensions dans les pièces en fonte mécanique." "The Elimination of Stresses in Machining Castings." "Proceedings of the Academie des Sciences." 1927, 1, 185, p. 1134.

2 A Le Thomas. "Les caracteres des fontes pour segments des piston." "The Characteristics of Irons used for Piston Rings." "Revue Industrielle." December, 1929, p. 801.

3 Frémont. "Nouvelles méthodes d'essais mécaniques de la fonte"—1920. "New Methods of Testing Cast Iron Mechanically—1920."

4 A. Le Thomas. "Les Altérations de la fonte aux Hautes Températures." "Alterations in Cast Iron at High Temperatures." "Congrès de Fonderie de Paris." 1929. September—Bulletin of the A.T.F.

### Pontiac Foundry to Reopen

The Pontiac Motor Company is spending $500,000 to renovate its grey-iron foundry at Pontiac, Mich., U.S.A., and bring its equipment up to date. Closed since the spring of 1932, the foundry is expected to reopen in December. A progressive charging plant is being installed to serve the cupolas. The conveyor system is being modernised to conform to changes in plant lay-out, a sand-blast and apron conveyor being added to provide progressive cleaning of castings. Chipping and sand-blasting are to replace milling in the cleaning of cylinders so that if any slag remains on the surface, it will be dug out. Waste sand will be reclaimed and used over in the foundry and in part of the core work. The Pantiac foundry was built in 1928 and has four cupolas with an output of 400 tons of castings a day.

# Refractory Concrete

It is an interesting fact that using "Ciment Fondu" any works engineer can make concrete which, whilst setting and hardening in the ordinary way, will remain stable up to 1,300 deg. C. and under certain conditions much above this temperature. Messrs. Lafarge Aluminous Cement Company, Limited, claim that if a concrete is made using alumina firebrick grog, or old broken alumina firebrick, as an aggregate with "Ciment Fondu," the concrete possesses quite remarkable refractory properties. It has very low expansion, possesses great strength (cold or hot), is extremely resistant to dilute acid attack and is extremely cheap to produce.

There are a multitude of jobs where such a concrete could be employed, the casting *in situ* of refractory linings to flues, and any other unit, where the temperature involved is below 1,300 deg. C., being an obvious sphere of utility. In fact, there seems to be no reason why many medium-temperature ovens and furnaces could not be cast as a concrete monolith with no joints whatsoever. These could even be lined with high-temperature refractories where high temperatures are to be met with, thus very

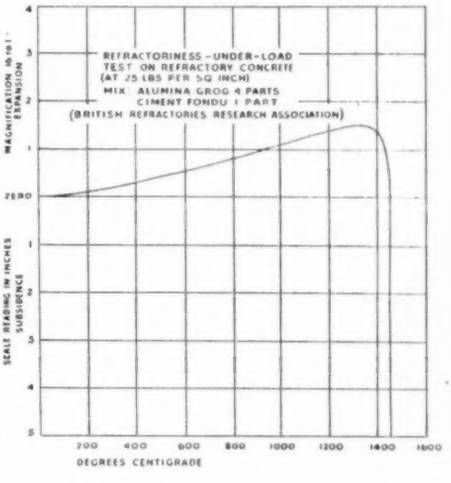



Fig. 1.—Refractoriness Test.

considerably reducing the cost of construction, and also the time necessary to construct many types of furnaces. Moreover, it should be cheap since the major ingredient can be the scrap firebrick readily available in most works. The concrete acquires great structural strength within 24 hrs. of being made without any necessity whatsoever for firing; it maintains a high strength even when fired to 1,300 deg. C., and can be cooled and heated alternately an indefinite number of times. A further useful property is that it can be allowed to absorb moisture when cold (after having been heated) without in any way detracting from its strength or its subsequent refractory properties.

The British Refractory Association have recently carried out some interesting tests on this material and the results of their determinations of the "refractoriness under load" of a mixture of the cement with alumina firebrick grog are shown in Fig. 1. Although the refractory property of the cement is of fundamental importance, the nature of the firebrick grog used as an aggregate is obviously equally important, and largely influences the maximum temperature at which the concrete will remain stable. Thus, if instead of alumina firebrick grog (or broken alumina firebrick) broken chromite or magnesite firebrick be used, stability is maintained at considerably higher temperatures.

# High-Pressure Economisers

## RECENT ADVANCES IN THE USE OF CAST IRON

The rapid advances that have been made during recent years in foundry practice and the production of high-grade, standard, uniform-quality irons are not yet universally realised in the engineering and allied industries. To-day it is hardly necessary to emphasise that foundry work has become an exact science since different high-grade standard irons can now be blended and any desired result obtained with certainty, quite different from the old "rule-of-thumb" quite sufficient for pressures up to, say, 250 lbs. per sq. in., while the "ring-stay" joint, in addition, will withstand a dead load of over 20 tons, so that economisers of this type, as already indicated, will operate at 400-500 lbs. pressure.

With regard to the advances in cast iron, particularly so far as it affects the economiser, the old British Admiralty standard of only about 25 years ago for cast iron was 9-11 tons per

FIG. 1.—VIEW IN THE FOUNDRY OF E. GREEN & SON, LIMITED, WAKEFIELD, SHOWING PART OF THE PITS FOR THE VERTICAL CASTING OF ECONOMISER TUBES.

days when the unfortunate foundryman had to struggle in the dark with iron of widely-varying quality.

As a result, castings will now stand much more severe conditions. The general position is well indicated by the cast-iron feed-water economiser for use with steam boilers. In Great Britain the tendency is still not to use cast iron for this purpose when the boiler pressure exceeds about 300 lbs. per sq. in., although in many other countries cast-iron economisers are operating with great success at 500-600 lbs. per sq. in. One well-known British firm also has actually supplied a considerable number of these installations.

Typical, for example, are the Centrale de Dock Sud electricity station, Buenos Aires, Argentine, operating at 498 lbs. per sq. in., and the Haaraa cellulose factory at Lievestuere, Finland, with 497 lbs. per sq. in. Other examples with the steam pressure in brackets are:—The Imabari power station, Japan (468 lbs.), the Genval paper mill, Belgium (426 lbs.), the Geertruidenberg power station, Holland (511 lbs.), the Kiel power station, Germany (568 lbs.), and the G. Haindl'sche paper mill, Augsburg, Germany (540 lbs.).

It may be remembered that the high-pressure vertical cast-iron tube economiser is equipped with a special "ring-stay" socket joint, and also in comparison with the ordinary standard design, has a smaller-diameter internal lid and a circular type of top header. In general the "ring-stay" joint consists of an external cast-iron ring plate containing a cast-iron split-ring, which is forced over the tube and into the ring plate and held tight against a machined shoulder by means of four set-screws. The ordinary economiser has frictional metal joints, which are sq. in. tensile breaking load, while the British Engineering Standard was 11 tons. Cast irons are now, of course, obtainable with a tensile strength of 17-20 tons, and to fix a limit therefore for about 300 lbs. pressure for cast-iron economisers is simply to ignore, on most unscientific lines, all modern foundry advancement.

The best type of economiser for given conditions requires careful study, and there are four main standard types of "Green" economiser

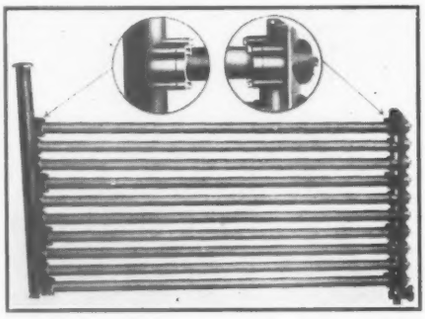


FIG. 2.—"GREEN" SPECIAL "RING-STAY" JOINT HIGH-PRESSURE CAST-IRON ECONOMISER OPERATED WITH SCRAPERS AS USUAL.

available, the ordinary vertical cast-iron tube, the high-pressure "ring-stay" vertical cast-iron tube, the horizontal cast-iron gilled tube, and the "Foster" horizontal steel tube with shrunk-on cast-iron gills for the very highest pressures, up to 2,000 lbs. per sq. in. if necessary.

# Rapid Hardness Testing

## AVERY'S IMPROVED MACHINE

In the machine illustrated the levers are totally enclosed, and the gauge is protected. The dashpot is situated directly underneath the weights, and the controls are grouped at the front of the machine and are very much handier for operation.

As is well known, the Avery rapid hardness tester determines the hardness of material by measuring the depth of penetration of standard penetrators under standard loading conditions and gives a visible indication of its degree according to established arbitrary scales. In all cases the measured impressions are superimposed on the impressions produced by a minor load of 10 kgs., which is applied automatically in the course of the test. The preliminary indentation is made in order to mitigate the influence of surface imperfections of the specimens.

There are two distinct sets of readings or scales on the dial. The inner scale "B," which

NEW AVERY HARDNESS TESTER.

is in red, applies when the standard $\frac{1}{8}$-in. dia. ball penetrator is used, and in this case the standard major load is 100 kgs. The outer scale "C," which is in black, applies when the conical diamond penetrator is used, and the standard major load is then 150 kgs. When referring to a hardness degree in terms of these standard scales, it is always necessary to use the prefix "B" or "C," with the appropriate numeral. It should, for example, be carefully noted that B.40 represents an entirely different degree of hardness from C.40. Scale "C" is used for testing hard specimens, and Scale "B" is used in other cases. There is an overlap, and it is generally laid down that materials with hardness below C.20 should be tested on the "B" Scale.

Comparative tests can also be made in addition to the two standard tests, and for this purpose the major load may be reduced to 60 kgs. The method of operating the improved machine is similar to that of the earlier model.

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THE PROGRESS REPORT OF General Refractories, Limited, for the six months to July 31, 1935, states that at the "Lowood" Brickworks, Deepcar, Sheffield, a complete silica brickmaking plant is being planned, and its installation will shortly be commenced.

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# "POLFORD"

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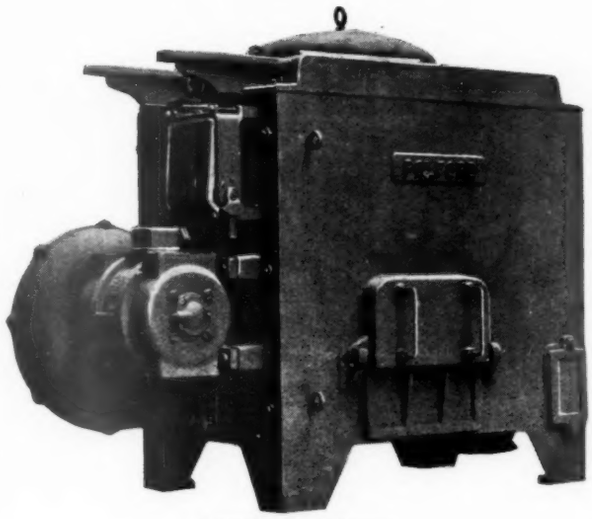
(REGISTERED)



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The **"Polford" Dryer** has been expressly designed for the economical drying of moulds in situ, ladles, etc.

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The construction of the **"Polford" Dryer** is such that the temperature is under complete control, so that burning is entirely eliminated, and an absolutely even dry is ensured, due to the setting up of a static pressure in the mould itself.

The fuel consumption is extremely low, being in the neighbourhood of 20 lbs. per hour, while the current consumed is negligible, the motor being less than one horse power.

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# This Week's News in Brief

## Trade Talk

THE S.S. "JAMAICA SETTLER," of 7,256 tons gross, has been bought by Messrs. Arnott Young & Company, Limited, for £12,000 for breaking up at their Clyde yard.

THE BURNTISLAND SHIPBUILDING COMPANY, LIMITED, have received an order to build a motor coaster of about 700 tons deadweight for Messrs. Metcalf, London.

DR. W. H. HATFIELD, F.R.S., technical director of Firth-Vickers Stainless Steels, Limited, gave an address to a meeting of the Institution of Production Engineers, held on Monday at Sheffield.

THE DIRECTORS of the Falkirk Iron Company, Limited, have decided to repay at par on January 1, 1936, all the outstanding 6 per cent. first mortgage debentures. Formal notice of this has been given to the holders.

BLAST-FURNACEMEN'S WAGES will be increased following the ascertainment of the selling price of Cleveland No. 3 pig-iron for the quarter ended September 30, which is returned at 59s. 8.07d. per ton. Wages as from October 6 will be advanced in consequence from 9 to 9.5 per cent. above the standard rate.

ACCORDING to the Russian journal, "Sa Industrialisaziju," the cost of producing pig-iron at the Wostokostalj works is about double that in the South Russian ironworks. In July the cost at Makejewka was 42.90 roubles, at Dsershinski 50.46 and in the Ural region from 86.60 to 120.50 roubles per ton of pig-iron.

AN EVENT of outstanding interest was the opening last Tuesday of the new Foundry School at Birmingham. It starts with an initial attendance of twelve students, all coming from industrial establishments. Particulars are available from the Honorary Treasurer, Mr. J. G. Pearce, 21, St. Paul's Square, Birmingham.

MESSRS. CALEDON SHIPBUILDING COMPANY, LIMITED, Dundee, have received an order from Messrs. Watta Watts & Company, Limited, London, for the construction of a shelter-deck cargo vessel of 9,000 tons deadweight. The machinery will be constructed by the North Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne, and installed at Dundee.

SIR SAMUEL ROBERTS, BT., M.P., for Eccleshall, was installed Master Cutler at Sheffield last week. The Cutlers' Feast was held last Thursday. On Friday a visit was paid to the works of Messrs. Newton Chambers & Company, Limited at Chapeltown, of which firm the new Master Cutler is chairman. Sir Samuel Roberts is a direct descendant of Robert Sorsby, who was made the first Master Cutler in 1624.

A NEW STEEL company, the Bengal Steel Corporation, with an authorised capital of Rs. 150,000,000, of which half will be in preference shares and half in ordinary shares, has been registered in Bengal for the manufacture of steel. The four directors of the company are: Mr. F. Graham Robert, Mr. W. T. Wizer Harmer, Mr. Carey Morgan and Mr. C. P. Perin, the last-named having been the consulting engineer of the Tata Iron & Steel Company for a number of years.

MESSRS. LITHGOWS, LIMITED, Port Glasgow, have secured an order to build a fruit-carrying vessel to run in the service of the Jamaica Banana Produces Association. The vessel is to be 5,535 tons, and will be fitted with two sets of six-cylinder Burmeister & Wain-Harland & Wolff latest-type two-cycle single-acting airless-injection Diesel engines built by Messrs. John G. Kincaid & Company, Limited, Greenock. The vessel will be the first motorship in the owners' banana-carrying trade.

"MIDLAND PARLIAMENT," the second of the new series of debates on the Young Entry into Industry, which have been arranged by the British Broadcasting Corporation, will be broadcast on November 13 at 7.30 p.m. The subject is "Blind Alley Jobs and Monotony," and those taking part are Sir Charles Mander, Bt., Mr. Herbert Buckler, a Leicestershire manufacturer, Mr. G. H. Jones, secretary of the Midland Miners' Federation, and Mr. J. Tranter, a young worker in a big Birmingham electrical firm.

IT IS ANNOUNCED that negotiations are proceeding which will result in an issue being made by Follsain Metals, Limited. An agreement is reported between Messrs. Sir W. G. Armstrong, Whitworth & Company (Ironfounders), Limited, and Follsain Metals, Limited, whereby Armstrong, Whitworth & Company will take up on a royalty basis the exclusive manufacture, treatment and sale in this country and in certain countries overseas of the metal alloys of Follsain Metals. The agreement does not prevent Follsain Metals either from continuing to supply its regular customers or from extending its activities.

## Contracts Open

**Slough,** October 23.—4,500 yds. 3-in. and 4-in. cast-iron pipes, for the Urban District Council. The Water Engineer's Office, Council Offices.

**Maldon,** October 28.—800 yds. of 3-in. cast-iron pipes, for the Rural District Council. Mr. W. Almond, engineer, 6, Market Hill, Maldon, Essex.

**Saffron Walden,** October 28.—Cast-iron pipes and special castings, for the Council. Messrs. Sands & Walker, Milton Chambers, Nottingham. (Fee £2 2s., returnable.)

**Hillhead,** October 19.—1,500 yds. of 3-in. and 500 yds. of 4-in. cast-iron socket and spigot pipes, for the Alnwick Rural District Council. Mr. O. M. Farrell, sanitary surveyor, 28, Bondgate Within, Alnwick.

**Hertford,** October 21.—980 yds. of 6-in. internal dia. and 720 yds. of 4-in. internal dia. mains; also 785 yds. of 4-in. internal dia. main, for the Town Council. The Borough Surveyor, The Castle, Hertford. (Fee £2 2s., returnable.)

## New Companies

*(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)*

**Brunst, Limited.**—Capital £100. Iron and brass founders and mechanical engineers, etc. Subscribers: N. W. Smyth, 161, Cheapside, London, E.C.2; P. P. B. Ramsay.

**Conrad Vaughan & Company, Limited,** Leabrook, Wednesbury, Staffs.—Capital £4,000. Founders, mechanical engineers, etc. Directors: C. Vaughan and G. T. E. Satchell.

**Chase Non-Ferrous Metal Company, Limited,** Station Works, Enfield Town, Middlesex.—Capital £5,000. Permanent directors: L. Whitworth and Mrs. O. E. Whitworth.

## Company Reports

**A. & J. Main & Company, Limited.**—Net profit of £2,536, reducing the debit brought in to £28,594.

**Kayser, Ellison & Company, Limited.**—Net profit, £40,968; brought in, £12,846; ordinary dividend of 7½ per cent.; depreciation, £5,000; to reserve, £10,000; carried forward, £14,064.

**British Piston Ring Company, Limited.**—Net profit, £48,800; brought in, £15,954; final dividend of 17½ per cent. on the ordinary shares, making 25 per cent. for the year; to general reserve, £10,000; carried forward, £28,254.

## Obituary

MR. ALBERT RUTHERFORD, a director of Messrs. Messrs. Jebb Bros., Limited, metal merchants, of Howard Street, Newcastle-upon-Tyne, has died, aged 41.

PROF. SIR J. C. MCLENNAN, F.R.S., the eminent Canadian physicist, died recently. Prof. McLennan, who was 68, was well known for his work on the production of helium and the superconductivity exhibited by certain metals and alloys at the extremely low temperatures obtainable with the aid of that gas in the liquid form. He was Professor of Physics at Toronto University from 1907 to 1932, and President in 1916-17 of the Royal Canadian Institute, and in 1924 of the Royal Society of Canada, from which he received the Flavelle medal in 1926. He was elected a Fellow of the Royal Society in 1915 (Royal Medallist in 1927), and was President of Section A of the British Association in 1923.

## Personal

MR. A. MCD. WESTWOOD, secretary of Messrs. Fleming & Ferguson, Limited, engineers and shipbuilders, Paisley, is retiring after 45 years' service with the firm.

MR. F. OLDERSHAW has been appointed foundry manager with Messrs. William Asquith, Limited, machine-tool makers, Halifax. His address now is 340, Carlton Villas, Gibbet Street, Halifax, Yorks.

MR. HERBERT CLARK has been appointed managing director of Messrs. Tangyes, Limited. Starting his career with Messrs. Tannet Walker, Limited, Messrs. Hawthorne Davy, Limited, of Leeds, and Henry Berry, Mr. Clark joined the Rolls-Royce organisation in America. On his return he was associated with Messrs. Hardy Spicer.

DURING THE LUNCHEON HOUR on Friday, at Shotts Iron Works, a presentation was made to Mr. Charles Henderson, on the occasion of his marriage. Mr. Henderson, who has been many years in the employ of the firm, received from Mr. A. B. Allison, works manager, on behalf of officials, staff, works and colliery employees, a timepiece suitably inscribed, a cake stand and a wallet of notes.

FOUR HUNDRED MEMBERS of the staff and workers of Messrs. Cameron & Roberton, Limited, Southbank Iron Works, Kirkintilloch, met in the new patternshop of the foundry on Tuesday evening, when ex-Provost T. W. Gibson, on behalf of the workmen, presented Mr. John Cameron, jun., with a large silver salver as a mark of appreciation on the occasion of his marriage, on October 9, to Miss Jean Wallace, of Auchenibert, Killearn. To mark the occasion the employees and ladies were entertained to a concert, supper and ball in the Kirkintilloch Town Hall, when over 800 were present.

### Wills

ANDERSON, WILLIAM NOBLE, Musselburgh, Midlothian, retired ironfounder ... £19,247

LANGER, DR. CARL, of Switzerland, a pioneer of the British-Canadian nickel industry and a founder director of the Mond Nickel Company, Limited; estate in England ... ... ... £10,266

HALL, F. J., chairman and managing director of Messrs. Hall & Rice, Limited, nail manufacturers, of West Bromwich, and of the Ridgacre Foundry Company, Limited ... ... £21,774

## Forthcoming Events

OCTOBER 24.

*Institute of Metals*:—"The Production and Control of Bronze Castings," Paper by F. W. Rowe, B.Sc., at the James Watt Memorial Institute, Birmingham, at 7 p.m.

**Institute of British Foundrymen**

OCTOBER 18.

*Middlesbrough Branch*:—"A Talk on the Production of Steel Castings," Paper by J. G. Wrightson, at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7.45 p.m.

*Sheffield and District Branch*:—"System in the Selling of Castings," Paper by E. N. Simons, at the Grand Hotel, Sheffield, at 7.30 p.m.

OCTOBER 19.

*Falkirk Section*:—(1) Presidental address; (2) "Moulding-Shop Problems." Paper by W. McArthur at the Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

*Lincolnshire Section*:—"Recent Developments in Foundry Practice," Paper by L. W. Bolton, A.M.I.Mech.E., at the Technical College, Monks Road, Lincoln, at 7 p.m.

*Newcastle-upon-Tyne and District Branch*:—Visit of Council of the Institute.

OCTOBER 23.

*Birmingham, Coventry and West Midlands Branch*:—Visit to F. H. Lloyd & Company, Limited, West Bromwich.

OCTOBER 25.

*Lancashire Branch (Junior Section)*:—(1) Presidential Address; (2) Presentation of Awards; (3) "Question Time," conducted by A. L. Key, at the College of Technology, Sackville Street, Manchester, at 7.30 p.m.

OCTOBER 26.

*East Midlands Branch*:—"Microscopy of Cast Metals," Paper by L. E. Benson, M.Sc., at Loughborough College, Loughborough, at 6 p.m.

*Wales and Monmouth Branch*:—"Some Further Notes on Balancing the Elements," Paper by F. J. Cook, M.I.Mech.E., at the University College, Newport Road, Cardiff, at 6.30 p.m.

XUM

# Light Castings need a *Fluid* Iron!

A free-running fluid iron is essential to produce clean, sharply-moulded light castings such as Rainwater pipes, Drain pipes, Builders' Hardware, Baths, Stoves, Gas and Electric Fires, etc. The relatively high phosphorus content of Rixon's (W'bro'.) No. 3 Foundry Iron ensures the necessary fluidity for this class of work.

Rixon's (W'bro'.) Irons are produced in two modern furnaces solely for the open market.

**Fluidity Test**

The illustration shows a typical spiral cast with a mixture containing Rixon's Iron. The feed to the spiral was only $\frac{3}{8}$-in. diameter.

**ANALYSIS**

| | Per Cent |
|---|---|
| Silicon ... ... ... ... | 3.29 |
| Sulphur ... ... ... ... | 0.025 |
| Phosphorus ... ... ... | 1.65 |
| Manganese ... ... ... | 0.34 |
| Graphitic Carbon ... ... | 3.52 |
| Combined Carbon ... ... | 0.12 |
| Total Carbon ... ... ... | 3.64 |

THE STANTON IRONWORKS COMPANY LIMITED
NEAR NOTTINGHAM

*The largest producers of Pig Iron (for Sale) in Great Britain*

**RIXON'S (W'BRO') No. 3 Foundry Iron**

# Raw Material Markets

Speculation is rife concerning the possibility of an embargo being put on the supply of war materials to Italy, but the export trade to that country has declined so much recently, owing to payment difficulties, that an embargo would not seriously affect producers in this country. The home demand for pig-iron continues to be very satisfactory and the recent spate of shipbuilding orders has expanded the outlet for production. The question of Mediterranean freight charges on iron ore is a cause of anxiety to manufacturers, and is likely to continue so while the Italo-Abyssinian hostilities remain. Discussions between the British Iron and Steel Federation and the Continental Steel Cartel on the subject of British exports are understood to have made favourable progress.

## Pig-Iron

**MIDDLESBROUGH.**—Very little new business is being transacted on this market, but the position is regarded with confidence and prices remain firm. Home consumers of foundry iron are bought for months ahead, and ironmasters are able to deliver as required. The export trade is still poor, only Denmark taking any substantial tonnage. Fixed price schedules are rigidly enforced for home transactions, No. 3 Cleveland G.M.B. being quoted at 67s. 6d. in the Middlesbrough area, 69s. 6d. on the North-East Coast, 67s. 3d. in the Falkirk district and 70s. 3d. in Glasgow.

Large sales of East Coast hematite have again been effected this week and forward contracts are still being discussed by some buyers. The rise in Mediterranean freight charges is causing some anxiety to producers, and should ironmasters' costs be advanced it would certainly mean that a revision in selling prices would have to be made. No. 1 East Coast hematite is at 71s. in the Middlesbrough area, 72s. on Tyneside, 73s. 6d. on the rest of the North-East Coast, 74s. in Scotland, 78s. 6d. in Sheffield and 84s. 6d. in Birmingham.

**LANCASHIRE.**—There has been a further decline in deliveries of pig-iron to some of the light-castings manufacturers, but as yet the decrease has not been very noticeable. Machine-tool makers are well employed and are taking up good tonnages of pig-iron. General engineers and the jobbing foundries are also consuming satisfactory quantities of pig-iron. The position regarding hematite is unchanged, and very few forward buying contracts are in circulation. Prices are firm, with Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron equal to Derbyshire, all on the basis of 74s. per ton delivered to consumers in the Lancashire price zone, Northamptonshire at 72s. 6d., Scottish No. 3 at around 81s. 6d., West Coast hematite at 81s., and East Coast at from 80s. 6d. to 81s.

**MIDLANDS.**—Deliveries of pig-iron in this district for September reached, in nearly every case, the best total for the year. Conditions at the present time are sound, and October deliveries should be no less satisfactory than those of the previous month. The majority of the consumers are well covered for several months, and, as a result, new business is not plentiful. Current prices are controlled and are as follow:—67s. 6d. for Northants No. 3, and 71s. for Derbyshire, Lincolnshire and North Staffs No. 3, including delivery to Birmingham and Black Country stations, and subject to a small rebate to heavy users under certain conditions. Demand for iron for the general engineering trade is satisfactory, and prices vary considerably. Special refined pig-iron is at between £5 7s. 6d. and £7; low-phosphorus, including Scottish iron, is from 85s. to 90s., and medium-phosphorus pig-iron from 72s. to 82s. 6d. delivered this district. Hematite is not being required to any great extent owing to earlier orders. Prices, including delivery to Midland stations in 10-ton lots, are 84s. 6d. per ton for West Coast mixed numbers and East Coast No. 1, and 83s. for Welsh mixed numbers, with 1s. 6d. per ton extra for delivery into users' works.

**SCOTLAND.**—Although there is very little new business being transacted, the Scottish pig-iron market continues to have a firm undertone. Prices are unchanged at the official minimum of 70s. for No. 3 foundry, f.o.t. furnaces, with 2s. 6d. per ton extra for No. 1. The light-castings founders continue to have large requirements, and the outlook seems to be favourable. Official quotations for Cleveland No. 3 are 67s. 3d. f.o.t. Falkirk and 70s. 3d. f.o.t. Glasgow. Other English foundry irons continue to be quoted at 1s. 3d. per ton under these figures. Basic and hematite brands of pig-iron are in heavy demand by local steelworks. Steel-making irons are quoted at:—Scottish hematite, 73s. 6d.; mixed numbers West Coast hematite, 74s.; mixed numbers East Coast hematite, 74s.; basic, British and Indian, 70s., less 5s. rebate, all delivered local steelworks.

## Coke

The foundry-coke market is unchanged, and there is now no possibility of any decrease in prices. Buying has been on a fairly large scale recently, and the majority of the ironfounders have now covered or are about to cover their needs over the next five or six months. For delivery in Birmingham and district, best Durham coke is from 37s. 6d. to 40s. and Welsh coke from 32s. 6d. to 43s. 6d. per ton.

## Steel

Active conditions rule in the steel market, and the demand in most branches has a tendency to expand, says the official report of the London Iron and Steel Exchange. The consuming industries are taking heavy deliveries, and buyers are showing a disposition to buy forward, but in several sections of the market the producers are reluctant to increase their already large forward commitments. A feature of the position in the semi-finished steel department is the pressure from consumers to secure delivery. Most users are working at a high rate, and although many of them have contracts extending for some months ahead, their requirements of supplementary tonnages amount to a heavy total. In most sections of the finished-steel market a good volume of business is passing. Substantial deliveries are being made of ship plates and sections, and most of the heavy-steel works have sufficient orders on their books to keep them well employed for several months.

## Scrap

Now that supplies of heavy melting steel from the United States have ceased to come into this country, the demand on home sources has increased considerably. The demand for ordinary heavy cast iron, on the Cleveland market, is active, and good machinery metal in handy sizes is also in demand, but prices are unaltered at 52s. 6d. and 54s. per ton respectively. The price of clean light cast iron is 42s. 6d. per ton, while cast-iron borings are nominal at 27s. 6d. The South Wales market is steady. Good heavy mild-steel scrap is quiet at 56s. to 57s. per ton, while bundled-steel scrap has an increased demand at 52s. to 54s. Heavy cast iron is in fair demand at 45s. There has been some active business in the Midland market, and prices are firm. Good heavy steel scrap in furnace sizes is at 46s. to 47s. 6d., and mixed heavy iron and steel is on offer at 44s. to 45s. Heavy machinery cast-iron scrap in convenient sizes is at 55s. to 57s. 6d., with good heavy at 50s. and clean light at 47s. 6d. per ton. Short heavy steel scrap as used in the foundries has an increased demand at 55s. to 57s. 6d. delivered works. A very firm undertone exists on the Lancashire market. In Scotland, prices are steady, and the turnover is good. First-quality heavy mild-steel melting scrap, in furnace sizes, is at 50s. per ton, while heavy basic or heavy iron and steel scrap mixed is 5s. less. Good piling wrought iron is at 57s. 6d. to 60s. per ton, and special quality is about 2s. 6d. extra. Clean cast-iron borings are at 37s. 6d. to 38s. 9d., first-class machinery cast-iron scrap in pieces not more than 1 cwt. is about 56s., and ordinary cast iron is at about 52s.

## Metals

**Copper.**—This market has been rather irregular during the week and prices have fluctuated considerably, with some profit-taking. Conditions are, however, satisfactory, and the demand for industrial purposes is fair. Italy has been in the market for fair tonnages of copper and all transactions with that country have been on strictly cash terms. The meeting that was arranged to discuss Italy's request for 60,000 tons of copper to be delivered next year has been postponed indefinitely. No doubt the question of sanctions being imposed on that country by the League of Nations was instrumental in the decision.

Daily market prices:—

*Cash.*—Thursday, £35 17s. 6d. to £35 18s. 9d.; Friday, £36 2s. 6d. to £36 3s. 9d.; Monday, £35 8s. 9d. to £35 11s. 3d.; Tuesday, £35 6s. 3d. to £35 7s. 6d.; Wednesday, £34 17s. 6d. to £34 18s. 9d.

*Three Months.*—Thursday, £36 5s. to £36 6s. 3d.; Friday, £36 11s. 3d. to £36 12s. 6d.; Monday, £35 16s. 3d. to £35 18s. 9d.; Tuesday, £35 12s. 6d. to £35 13s. 9d.; Wednesday, £35 2s. 6d. to £35 3s. 9d.

**Tin.**—This metal has also been very irregular this week. The political unrest and the rigid quota system have both had their effect on the market. Consumption has been fairly well maintained, particularly on the Continent, where some large sales have been transacted. The demand has mainly been for armament uses, but in the home market the tinplate manufacturers have taken some large tonnages.

Day-to-day fluctuations:—

*Cash.*—Thursday, £233 10s. to £234; Friday, £238 to £242 (nom.); Monday, £243 to £248; Tuesday, £242 to £243; Wednesday, £228 to £229.

*Three Months.*—Thursday, £222 15s. to £223; Friday, £227 10s. to £228; Monday, £224 10s. to £225; Tuesday, £225 15s. to £226; Wednesday, £217 to £217 10s.

**Spelter.**—Consumption has, on the whole, been fairly well maintained, especially in the brass trade, where large tonnages are being taken up. Spelter for use in galvanising is still in very poor demand. American stocks at the end of September had decreased by about 6,000 tons as compared with the previous month.

Official quotations were as follow:—

*Ordinary.*—Thursday, £17; Friday, £17 2s. 6d.; Monday, £16 11s. 3d.; Tuesday, £16 6s. 3d.; Wednesday, £16 2s. 6d.

**Lead.**—The condition of this market remains very sound and consumption is at a high level, although the amount of new business has declined. Consumption on the Continent has been very high and it seems probable that European consumption for this year will reach record dimensions. The Mexican smelters' strike, which lasted for nearly two months, is now over.

Day-to-day quotations:—

*Soft Foreign (Prompt).*—Thursday, £19 7s. 6d.; Friday, £19 10s; Monday, £18 18s. 9d.; Tuesday, £18 15s.; Wednesday, £18 2s. 6d.

## Catalogue Received

**Run-Out Jib Cranes.** A four-page leaflet, received from Herbert Morris, Limited, of Loughborough, describes and illustrates an electrically-operated jib crane for serving first-floor stores in the matter of loading or unloading direct from truck or wagon. The design is such that all parts are housed with the actual shop.

**GANISTER**

**Purchase your supplies from actual Producers with over 50 years' reputation**

Scientifically treated, specially ground Ganister for Cupolas, Iron & Steel Works, &c.

**SPECIAL LADLE GANISTER**

**TRIAL BAGS FREE**
Quotations on application

**The ASTBURY SILICA CO.**
**CONGLETON, Cheshire**
***Est. 50 Years***

*Whether you did, or did not pay a visit to our Stand at the*

**FOUNDRY TRADES EXHIBITION...**

*... we shall be pleased to meet you at our*

**NEW ADDRESS**

*at* **Genefax House, Tapton Park Road, Sheffield.**

★ In a "Fulwood" or "Nether Green" tramcar—which starts at the end of Leopold Street and stops at Tapton Park Road—it is less than 15 minutes run to GENEFAX HOUSE.

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Telephone: Central 5250.

# RAW MATERIALS—PRICE LIST

**(Wednesday, October 16, 1935)**

## COPPER

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 34 | 17 | 6 |
| Three months | 35 | 2 | 6 |
| Electrolytic | 39 | 0 | 0 |
| Tough | 38 | 0 | 0 |
| Best selected | 38 | 10 | 0 |
| Sheets | 68 | 0 | 0 |
| India | 50 | 10 | 0 |
| Wire bars | 40 | 15 | 0 |
| Ingot bars | 40 | 15 | 0 |
| H.C. wire rods | 44 | 5 | 0 |
| Off. av. cash, Sept. | 34 | 1 | 5⅝ |
| Do., 3 mths., Sept. | 34 | 9 | 5 1/16 |
| Do., Sttlmnt., Sept. | 34 | 1 | 6⅛ |
| Do., Electro, Sept. | 38 | 4 | 10⅛ |
| Do., B.S., Sept. | 37 | 9 | 4½ |
| Do., wire bars, Sept. | 38 | 10 | 8⅛ |
| Solid drawn tubes | | | 10½d. |
| Brazed tubes | | | 10½d. |
| Wire | | | 6½d. |

## BRASS

| | |
|---|---|
| Solid drawn tubes | 9¾d. |
| Brazed tubes | 11¾d. |
| Rods, drawn | 8⅝d. |
| Rods, extd. or rlld. | 5d. |
| Sheets to 10 w.g. | 8¼d. |
| Wire | 7⅛d. |
| Rolled metal | 7⅛d. |
| Yellow metal rods | 5d |
| Do. 4 × 4 Squares | 5⅜d. |
| Do. 4 × 3 Sheets | 5⅜d. |

## TIN

| | £ | s. | d. |
|---|---|---|---|
| Standard cash | 228 | 0 | 0 |
| Three months | 217 | 0 | 0 |
| English | 228 | 10 | 0 |
| Bars | 230 | 0 | 0 |
| Straits (nom.) | 228 | 10 | 0 |
| Australian (nom.) | 228 | 10 | 0 |
| Eastern | 220 | 0 | 0 |
| Banca (nom.) | 229 | 0 | 0 |
| Off. av. cash, Sept. | 224 | 3 | 3⅜ |
| Do., 3 mths., Sept. | 212 | 12 | 4⅛ |
| Do., Sttlmt., Sept. | 224 | 2 | 7⅞ |

## SPELTER

| | £ | s. | d. |
|---|---|---|---|
| Ordinary | 16 | 2 | 6 |
| Remelted | 15 | 12 | 6 |
| Hard | 13 | 10 | 0 |
| Electro 99.9 | 18 | 16 | 3 |
| English | 17 | 10 | 0 |
| India | 14 | 15 | 0 |
| Zinc dust | 20 | 0 | 0 |
| Zinc ashes | 4 | 15 | 0 |
| Off. aver., Sept. | 15 | 10 | 3⅛ |
| Aver. spot, Sept. | 15 | 8 | 3⅜ |

## LEAD

| | £ | s. | d. |
|---|---|---|---|
| Soft foreign ppt. | 18 | 2 | 6 |
| Empire (nom.) | 19 | 10 | 0 |
| English | 20 | 5 | 0 |
| Off. average, Sept. | 16 | 5 | 9⅜ |
| Average spot, Sept. | 16 | 5 | 2⅞ |

## ALUMINIUM

| | |
|---|---|
| Ingots | £100 to £105 |
| Wire | 1/1 to 1/9 lb |
| Sheet and foil | 1/2 to 2/9 lb |

## ZINC SHEETS, &c.

| | £ | s. | d. |
|---|---|---|---|
| Zinc sheets, English | 25 | 5 | 0 |
| Do., V.M. ex-whse. | 26 | 5 | 0 |
| Rods | 29 | 10 | 0 |

## ANTIMONY

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| English | 83 | 0 | 0 | to | 84 | 0 | 0 |
| Chinese, ex-whse. | | | | | 74 | 0 | 0 |
| Crude, c.i.f. | | | | | 38 | 0 | 0 |

## QUICKSILVER

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Quicksilver | 11 | 10 | 0 | to | 12 | 0 | 0 |

## FERRO-ALLOYS AND STEEL-MAKING METALS

| | |
|---|---|
| Ferro-silicon— | |
| 25% | 8 17 6 |
| 45/50% | 12 15 0 |
| 75% | 17 17 6 |
| Ferro-vanadium— | |
| 35/50% | 12/8 lb. Va. |
| Ferro-molybdenum— | |
| 70/75% carbon-free | 4/6 lb. Mo. |
| Ferro-titanium— | |
| 23/25% carbon-free | 9d. lb. |
| Ferro-phosphorus, 20/25% | £18 0 0 to £20 0 0 |
| Ferro-tungsten— | |
| 80/85% | 3/- lb. |
| Tungsten metal powder— | |
| 98/99% | 3/3 lb. |
| Ferro-chrome— | |
| 2/4% car. | 33 0 0 |
| 4/6% car. | 21 15 0 |
| 6/8% car. | 21 0 0 |
| 8/10% car. | 21 0 0 |
| Ferro-chrome— | |
| Max. 2% car. | 34 0 0 |
| Max. 1% car. | 36 5 0 |
| Max. 0.70% car. | 37 5 0 |
| 70% carbon-free | 9½d. lb. |
| Nickel—99.5/100% | £200 to £205 |
| "F" nickel shot | £184 0 0 |
| Ferro-cobalt, 98/99% | 5/6 lb. |
| Metallic chromium— | |
| 96/98% | 2/5 lb. |
| Ferro-manganese (net)— | |
| 76/80% loose | £10 15 0 to 11 5 0 |
| 76/80% packed | £11 15 0 to 12 5 0 |
| 76/80% export | (nom.) £9 15 0 |
| Metallic manganese— | |
| 94/96% carbon-free | 1/3 lb. |

Per ton unless otherwise stated.

## HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to 1/16 in. 1/- lb.
Flats, ½ in. × ⅛ in. to under 1 in. × ⅛ in. 3d. lb.
Do., under ¼ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

## SCRAP

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| South Wales— | | | | | | | |
| Heavy steel | 2 | 16 | 0 | to | 2 | 17 | 0 |
| Mixed iron and steel | 2 | 11 | 0 | to | 2 | 13 | 0 |
| Heavy cast iron | | | | | 2 | 15 | 0 |
| Good machinery | 2 | 15 | 0 | to | 2 | 17 | 0 |
| Cleveland— | | | | | | | |
| Heavy steel | | | | | 2 | 12 | 6 |
| Steel turnings | | | | | 1 | 17 | 6 |
| Cast-iron borings | | | | | 1 | 7 | 6 |
| Heavy cast iron | | | | | 2 | 12 | 6 |
| Heavy machinery | | | | | 2 | 14 | 0 |
| Midlands— | | | | | | | |
| Light cast-iron scrap | | | | | 2 | 7 | 6 |
| Heavy wrought iron | 2 | 17 | 6 | to | 3 | 0 | 0 |
| Steel turnings | | | | | 1 | 14 | 6 |
| Scotland— | | | | | | | |
| Heavy steel | | | | | 2 | 10 | 0 |
| Ordinary cast iron | 2 | 11 | 6 | to | 2 | 12 | 6 |
| Engineers' turnings | | | | | 2 | 0 | 0 |
| Cast-iron borings | 1 | 17 | 6 | to | 1 | 18 | 9 |
| Wrot-iron piling | 2 | 17 | 6 | to | 3 | 0 | 0 |
| Heavy machinery | | | | | 2 | 16 | 0 |

London—Merchants' buying prices, delivered yard.

| | £ | s. | d. |
|---|---|---|---|
| Copper (clean) | 31 | 0 | 0 |
| Brass | 20 | 0 | 0 |
| Lead (less usual draft) | 17 | 0 | 0 |
| Tea lead | 13 | 0 | 0 |
| Zinc | 10 | 0 | 0 |
| New aluminium cuttings | 70 | 0 | 0 |
| Braziery copper | 28 | 0 | 0 |
| Gunmetal | 28 | 0 | 0 |
| Hollow pewter | 155 | 0 | 0 |
| Shaped black pewter | 125 | 0 | 0 |

## PIG-IRON

N.E. Coast (d/d Tees-side area)—

| | |
|---|---|
| Foundry No. 1 | 70/- |
| Foundry No. 3 | 67/6 |
| ,, at Falkirk | 67/3 |
| ,, at Glasgow | 70/3 |
| Foundry No. 4 | 66/6 |
| Forge No. 4 | 66/6 |
| Hematite No. 1 | 71/- |
| Hematite M/Nos. | 70/6 |

N.W. Coast—

| | |
|---|---|
| Hem. M/Nos. d/d Glas. | 74/- |
| ,, d/d Birm. | 84/6 |
| Malleable iron d/d Birm. | 115/- |

Midlands (d/d Birmingham dist.)—

| | |
|---|---|
| Staffs No. 4 forge | 67/- |
| ,, No. 3 fdry. | 71/- |
| Northants forge | 63/6 |
| ,, fdry. No. 3 | 67/6 |
| ,, fdry. No. 1 | 70/6 |
| Derbyshire forge | 67/- |
| ,, fdry. No. 3 | 71/- |
| ,, fdry. No. 1 | 74/- |

Scotland—

| | |
|---|---|
| Foundry No. 1, f.o.t. | 72/6 |
| ,, No. 3, f.o.t. | 70/- |
| Hem. M/Nos. d/d | 73/6 |

Sheffield (d/d district)—

| | |
|---|---|
| Derby forge | 64/6 |
| ,, fdry. No. 3 | 68/6 |
| Lincs forge | 64/6 |
| ,, fdry. No. 3 | 68/6 |
| W.C. hematite | 86/- |

Lancashire (d/d eq. Man.)—

| | |
|---|---|
| Derby fdry. No. 3 | 74/- |
| Staffs fdry. No. 3 | 74/- |
| Northants fdry. No. 3 | 72/6 |
| Cleveland fdry. No. 3 | 74/- |
| Dalzell. No. 3 (special) | 102/6 to 105/- |
| Glengarnock, No. 3 | 81/6 |
| Clyde, No. 3 | 81/6 |
| Monkland, No. 3 | 81/6 |
| Summerlee, No. 3 | 81/6 |
| Eglinton, No. 3 | 81/6 |
| Gartsherrie, No. 3 | 81/6 |
| Shotts, No. 3 | 81/6 |

## FINISHED IRON AND STEEL

*Usual district deliveries for iron; delivered consumer's station for steel.*

| Iron— | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Bars (cr.) | 9 | 12 | 6 | to | 9 | 15 | 0 |
| Nut and bolt iron | 7 | 10 | 0 | to | 8 | 0 | 0 |
| Hoops | 10 | 10 | 0 | and up. | | | |
| Marked bars (Staffs) f.o.t. | | | | 12 | 0 | 0 | |
| Gas strip | 10 | 10 | 0 | and up. | | | |
| Bolts and nuts, ¾ in. × 4 in. | 15 | 0 | 0 | and up. | | | |
| Steel— | | | | | | | |
| Plates, ship, etc. | 8 | 15 | 0 | to | 8 | 17 | 6 |
| Boiler plts. | 9 | 5 | 0 | to | 9 | 7 | 6 |
| Chequer plts. | | | | 10 | 7 | 6 | |
| Angles | | | | 8 | 7 | 6 | |
| Tees | | | | 9 | 7 | 6 | |
| Joists | | | | 8 | 15 | 0 | |
| Rounds and squares, 3 in. to 5½ in. | | | | 9 | 7 | 6 | |
| Rounds under 3 in. to ⅜ in. (Untested) | | | | 8 | 12 | 0 | |
| Flats—8 in. wide and over | | | | 8 | 12 | 6 | |
| ,, under 8 in. and over 5 in. | | | | 8 | 17 | 6 | |
| Rails, heavy | 8 | 5 | 0 | to | 8 | 10 | 0 |
| Fishplates | 12 | 5 | 0 | to | 12 | 10 | 0 |
| Hoops (Staffs) | | | | 9 | 7 | 0 | |
| Black sheets, 24g. (4-t. lots) | | | | 11 | 0 | 0 | |
| Galv. cor. shts. ( ,, ) | | | | 13 | 0 | 0 | |
| Galv. flat shts. ( ,, ) | | | | 13 | 10 | 0 | |
| Galv. fencing wire, 8g. plain | | | | 14 | 10 | 0 | |
| Billets, soft | 5 | 10 | 0 | and up. | | | |
| Billets, hard | 6 | 17 | 6 | to | 7 | 2 | 6 |
| Sheet bars | 5 | 5 | 0 | to | 5 | 10 | 0 |
| Tin bars | 5 | 5 | 0 | to | 5 | 10 | 0 |

## PHOSPHOR BRONZE

| | Per lb. basis. |
|---|---|
| Strip | 10½d. |
| Sheet to 10 w.g. | 11¼d. |
| Wire | 12½d. |
| Rods | 11¼d. |
| Tubes | 14d. |
| Castings | 12¼d. |

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

## NICKEL SILVER, &c.

| | Per lb. |
|---|---|
| Ingots for raising | 7d. to 1/1 |
| Rolled— | |
| To 9 in. wide | 1/1 to 1/7 |
| To 12 in. wide | 1/1¼ to 1/7½ |
| To 15 in. wide | 1/1½ to 1/7½ |
| To 18 in. wide | 1/2 to 1/8 |
| To 21 in. wide | 1/2½ to 1/8½ |
| To 25 in. wide | 1/3 to 1/9 |
| Ingots for spoons and forks | 7d. to 1/3½ |
| Ingots rolled to spoon size | 10d. to 1/6½ |
| Wire round— | |
| to 10g. | 1/4½ to 1/11½ |

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

## AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

| | Dols. |
|---|---|
| No. 2 foundry, Phila. | 20.[illegible] |
| No. 2 foundry, Valley | 18.50 |
| No. 2 foundry, Birm. | 14.50 |
| Basic, Valley | 18.00 |
| Malleable, Valley | 18.50 |
| Grey forge, Valley | 18.00 |
| Ferro-mang. 80%, seaboard | 85.00 |
| O.-h. rails, h'y, at mill | 36.37½ |
| Billets | 27.00 |
| Sheet bars | 28.00 |
| Wire rods | 38.00 |
| | Cents. |
| Iron bars, Chicago | 1.90 |
| Steel bars | 1.85 |
| Tank plates | 1.80 |
| Beams, etc. | 1.80 |
| Skelp, grooved steel | 1.70 |
| Steel hoops | 2.10 |
| Sheets, black, No. 24 | 2.40 |
| Sheets, galv., No. 24 | 3.10 |
| Wire nails | 2.40 |
| Plain wire | 2.30 |
| Barbed wire, galv. | 2.80 |
| Tinplates, 100-lb. box | $5.25 |

## COKE (at ovens)

| | |
|---|---|
| Welsh foundry | 25/- to 30/- |
| ,, furnace | 19/- to 20/- |
| Durham foundry | 20/- to 21/- |
| ,, furnace | 16/6 to 17/9 |
| Scotland, foundry | 28/- |
| ,, furnace | 25/- |

## TINPLATES

f.o.b. Bristol Channel ports.

| | | |
|---|---|---|
| I.C. cokes | 20×14 per box | 18/2 and up. |
| ,, | 28×20 ,, | 36/4 and up. |
| ,, | 20×10 ,, | 26/- to 26/3 |
| ,, | 18¾×14 ,, | 18/9 to 19/- |
| C.W. | 20×14 ,, | 15/6 |
| ,, | 28×20 ,, | 32/6 |
| ,, | 20×10 ,, | 22/9 |
| ,, | 18¾×14 ,, | 15/6 |

## SWEDISH CHARCOAL IRON & STEEL

| | £ | s. | d. | | £ | s. | d. |
|---|---|---|---|---|---|---|---|
| Pig-iron | £6 | 0 | 0 | to | £7 | 0 | 0 |
| Bars-hammered, basis | £16 | 0 | 0 | to | £16 | 10 | 0 |
| Bars and nail-rods, rolled, basis | £15 | 15 | 0 | to | £16 | 0 | 0 |
| Blooms | £10 | 0 | 0 | to | £12 | 0 | 0 |
| Keg steel | £30 | 0 | 0 | to | £31 | 0 | 0 |
| Faggot steel | £18 | 0 | 0 | to | £23 | 0 | 0 |
| Bars and rods dead soft, st'l | £10 | 0 | 0 | to | £12 | 0 | 0 |

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr. 18.16 to £1.]

XUM

## DAILY FLUCTUATIONS

### Standard Copper (cash)

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 35 | 17 | 6 | inc. | 1/3 |
| ,, 11 .. | 36 | 2 | 6 | ,, | 5/- |
| ,, 14 .. | 35 | 8 | 9 | dec. | 13/9 |
| ,, 15 .. | 35 | 6 | 3 | ,, | 2/6 |
| ,, 16 .. | 34 | 17 | 6 | ,, | 8/9 |

### Electrolytic Copper

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 40 | 5 | 0 | inc. | 5/- |
| ,, 11 .. | 40 | 10 | 0 | ,, | 5/- |
| ,, 14 .. | 40 | 0 | 0 | dec. | 10/- |
| ,, 15 .. | 40 | 0 | 0 | No | change |
| ,, 16 .. | 39 | 0 | 0 | dec. | 20/- |

### Standard Tin (cash)

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 233 | 10 | 0 | inc. | 85/- |
| ,, 11 .. | 238 | 0 | 0 | ,, | 90/- |
| ,, 14 .. | 243 | 0 | 0 | ,, | 100/- |
| ,, 15 .. | 242 | 0 | 0 | dec. | 20/- |
| ,, 16 .. | 228 | 0 | 0 | ,, | 280/- |

### Tin (English ingots)

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 233 | 15 | 0 | inc. | 85/- |
| ,, 11 .. | 240 | 10 | 0 | ,, | 135/- |
| ,, 14 .. | 245 | 10 | 0 | ,, | 100/- |
| ,, 15 .. | 242 | 10 | 0 | dec. | 60/- |
| ,, 16 .. | 228 | 10 | 0 | ,, | 280/- |

### Spelter (ordinary)

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 17 | 0 | 0 | inc. | 5/- |
| ,, 11 .. | 17 | 2 | 6 | ,, | 2/6 |
| ,, 14 .. | 16 | 11 | 3 | dec. | 11/3 |
| ,, 15 .. | 16 | 6 | 3 | ,, | 5/- |
| ,, 16 .. | 16 | 2 | 6 | ,, | 3/9 |

### Spelter (Electro, 99.9 per cent.)

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 19 | 12 | 6 | inc. | 5/- |
| ,, 11 .. | 19 | 15 | 0 | ,, | 2/6 |
| ,, 14 .. | 19 | 5 | 0 | dec. | 10/- |
| ,, 15 .. | 19 | 0 | 0 | ,, | 5/- |
| ,, 16 .. | 18 | 16 | 3 | ,, | 3/9 |

### Zinc Sheets (English)

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 25 | 15 | 0 | inc. | 5/- |
| ,, 11 .. | 25 | 17 | 6 | ,, | 2/6 |
| ,, 14 .. | 25 | 10 | 0 | dec. | 7/6 |
| ,, 15 .. | 25 | 5 | 0 | ,, | 5/- |
| ,, 16 .. | 25 | 5 | 0 | No | change |

### Lead (English)

| | £ | s. | d. | | |
|---|---|---|---|---|---|
| Oct. 10 .. | 21 | 5 | 0 | inc. | 5/- |
| ,, 11 .. | 21 | 10 | 0 | ,, | 5/- |
| ,, 14 .. | 21 | 0 | 0 | dec. | 10/- |
| ,, 15 .. | 20 | 15 | 0 | ,, | 5/- |
| ,, 16 .. | 20 | 5 | 0 | ,, | 10/- |

## AVERAGE MONTHLY PRICES OF FURNACE COKE D/D MIDDLESBROUGH

| Year. | January. | February. | March. | April. | May. | June. | July. | August. | September. | October. | November. | December. | Yearly average. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| 1903 .. .. | 0 15 9 | 0 16 0 | 0 16 3 | 0 16 9 | 0 16 6 | 0 16 3 | 0 16 0 | 0 15 9 | 0 15 6 | 0 15 0 | 0 14 6 | 0 14 0 | 0 15 8½ |
| 1904 .. .. | 0 13 9 | 0 13 9 | 0 13 3 | 0 14 3 | 0 14 6 | 0 14 3 | 0 14 3 | 0 14 3 | 0 14 3 | 0 14 0 | 0 14 0 | 0 14 6 | 0 14 1½ |
| 1905 .. .. | 0 14 9 | 0 15 3 | 0 15 3 | 0 15 3 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 9 | 0 17 0 | 0 15 5½ |
| 1906 .. .. | 0 17 6 | 0 17 6 | 0 17 0 | 0 17 0 | 0 17 0 | 0 16 6 | 0 17 0 | 0 17 0 | 0 18 3 | 0 18 6 | 0 19 0 | 1 0 0 | 0 17 8½ |
| 1907 .. .. | 1 4 6 | 1 5 0 | 1 5 0 | 1 0 6 | 1 2 0 | 1 1 0 | 1 1 0 | 1 1 0 | 1 2 0 | 1 1 6 | 1 0 0 | 0 17 0 | 1 1 8½ |
| 1908 .. .. | 0 16 0 | 0 16 0 | 0 15 6 | 0 16 0 | 0 16 3 | 0 16 0 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 3 | 0 16 0 | 0 16 0 | 0 15 9½ |
| 1909 .. .. | 0 16 0 | 0 15 3 | 0 15 0 | 0 14 9 | 0 15 6 | 0 15 9 | 0 15 6 | 0 15 6 | 0 16 6 | 0 17 0 | 0 17 6 | 0 17 0 | 0 15 11½ |
| 1910 .. .. | 0 18 4½ | 0 18 6½ | 0 18 0 | 0 18 0 | 0 17 10½ | 0 17 0 | 0 16 1½ | 0 15 9½ | 0 15 11 | 0 16 0 | 0 15 9½ | 0 15 8 | 0 16 11 |
| 1911 .. .. | 0 16 0 | 0 15 10½ | 0 15 6 | 0 15 3 | 0 14 9 | 0 14 6 | 0 14 6 | 0 14 6 | 0 14 6 | 0 14 11½ | 0 15 0½ | 0 16 3½ | 0 15 1½ |
| 1912 .. .. | 0 17 3 | 0 17 3 | 0 18 6 | 0 18 10 | 0 19 0 | 0 19 4½ | 0 19 10½ | 1 0 9½ | 1 2 9 | 1 4 1½ | 1 5 8½ | 1 8 6 | 1 1 0 |
| 1913 .. .. | 1 5 9 | 1 4 11 | 1 5 0 | 1 5 0 | 1 4 9½ | 1 0 4½ | 0 19 5½ | 0 18 3 | 0 18 0 | 0 18 2½ | 0 18 6 | 0 18 6 | 1 1 4½ |
| 1914 .. .. | 0 18 2 | 0 17 1 | 0 17 0 | 0 17 0 | 0 17 4 | 0 17 6 | 0 17 6 | 0 18 5 | 0 18 4 | 0 17 9 | 0 17 6 | 0 18 5 | 0 17 8 |
| 1915 .. .. | 0 17 10½ | 0 17 9 | 1 0 4½ | 1 7 7½ | 1 9 4½ | 1 10 7½ | 1 9 7 | 1 7 3 | 1 5 4 | 1 4 9 | 1 9 6 | 1 13 0 | 1 6 1 |
| 1916 .. .. | 1 10 9 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6½ |
| 1917 .. .. | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 10 6 | 1 14 3 | 1 15 6 | 1 11 2½ |
| 1918 .. .. | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 |
| 1919 .. .. | 1 15 6 | 1 15 6 | 1 15 6 | 1 15 6 | 2 1 6 | 2 1 6 | 2 3 9 | 2 10 6 | 2 10 6 | 2 10 6 | 2 10 6 | 2 10 6 | 2 3 5 |
| 1920 .. .. | 2 12 3 | 2 14 0 | 2 19 0 | 2 19 0 | 3 3 8 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 6 0 | 3 2 6 |
| 1921 .. .. | 3 1 0½ | 2 19 0 | 2 16 0 | 2 7 0 | 2 6 6 | 2 6 6 | 2 0 6 | 2 0 0 | 1 13 11 | 1 12 9 | 1 10 4½ | 1 8 3 | 2 3 6½ |
| 1922 .. .. | 1 7 0½ | 1 8 1½ | 1 9 7½ | 1 8 4½ | 1 7 11½ | 1 7 3 | 1 6 9½ | 1 6 10½ | 1 7 0½ | 1 10 2½ | 1 10 0 | 1 9 11½ | 1 8 3½ |
| 1923 .. .. | 1 11 3 | 1 14 6 | 2 0 1½ | 2 2 8½ | 2 4 4½ | 2 2 10½ | 2 1 0½ | 2 1 6 | 2 0 9½ | 1 18 9 | 1 18 8½ | 1 18 3 | 1 19 7½ |
| 1924 .. .. | 1 16 6½ | 1 14 9 | 1 11 11½ | 1 10 0½ | 1 8 1½ | 1 7 8½ | 1 7 3 | 1 6 3 | 1 6 0 | 1 5 0 | 1 5 0 | 1 5 0 | 1 9 5½ |
| 1925 .. .. | 1 4 10½ | 1 4 1½ | 1 13 3 | 1 2 4½ | 1 2 2½ | 1 1 5½ | 1 1 3½ | 1 4 9 | 0 18 10½ | 0 18 4½ | 0 19 6½ | 1 1 4½ | 1 2 8½ |
| 1926 .. .. | 1 2 1½ | 1 0 9 | 0 19 2½ | 0 18 6½ | * | * | * | * | * | * | * | 1 5 0 | 1 1 1‖ |
| 1927 .. .. | 1 5 6 | 1 4 9½ | 1 6 1½ | 1 3 9 | 1 2 6 | 1 0 8½ | 0 19 4½ | 0 19 0 | 0 18 7½ | 0 18 0 | 0 17 10½ | 0 17 6 | 1 1 1‖ |
| 1928 .. .. | 0 17 6 | 0 17 10½ | 0 18 0½ | 0 17 11½ | 0 17 8½ | 0 17 6½ | 0 17 7½ | 0 17 6½ | 0 17 6 | 0 17 7½ | 0 17 7½ | 0 17 6 | 0 17 8 |
| 1929 .. .. | 0 17 7½ | 0 18 0 | 0 19 0 | 0 19 6½ | 0 18 10½ | 0 19 10½ | 1 1 3½ | 1 1 8½ | 1 3 0 | 1 3 6 | 1 3 8 | 1 3 1½ | 1 0 9½ |
| 1930 .. .. | 1 2 6½ | 1 1 3 | 1 0 3 | 0 19 1½ | 0 17 7 | 0 16 10½ | 0 16 6 | 0 16 6 | 0 16 9 | 0 17 0 | 0 17 0 | 0 17 0 | 0 18 2½ |
| 1931 .. .. | 0 17 0 | 0 16 7½ | 0 16 0 | 0 16 0 | 0 15 11 | 0 15 5 | 0 15 1 | 0 15 0 | 0 15 0 | 0 16 9 | 0 17 0 | 0 16 6 | 0 16 0½ |
| 1932 .. .. | 0 17 0 | 0 16 11½ | 0 16 5½ | 0 15 9 | 0 15 7½ | 0 15 6 | 0 15 6 | 0 14 9½ | 0 14 6½ | 0 14 6 | 0 14 6 | 0 15 4 | 0 15 6½ |
| 1933 .. .. | 0 16 0½ | 0 15 11½ | 0 15 6½ | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 6 | 0 15 8½ | 0 16 1½ | 0 17 0 | 0 17 6 | 0 18 0 | 0 16 1½ |
| 1934 .. .. | 0 19 1½ | 1 0 6 | 1 0 2 | 1 0 0 | 1 0 0 | 1 0 0 | 1 0 0 | 1 0 0 | 1 0 0 | 1 0 0 | 1 0 0 | 1 0 0 | 0 19 11½ |
| 1935 .. .. | 1 0 0 | 0 19 6½ | 0 19 0½ | 0 19 0 | 0 19 0 | 0 19 0 | 0 19 0 | 0 19 0 | 0 19 0 | — | — | — | — |

* Strike period. ‖ Five months.


WILLIAM JACKS & COMPANY,

WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.

13, RUMFORD STREET, LIVERPOOL.

PIG IRON

REGISTERED TRADE MARK

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY,

CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.

ZETLAND ROAD, MIDDLESBROUGH.

## NOTICE

**STEEL GRIT.**—**Messrs. Fairways Ltd., 102, Westferry Road, London, E.14:** intend to make Steel Grit at their London Wharf, and invite communications from—

(1) Practical foremen able to equip and run a modern Steel-Grit plant.

(2) Firm able to supply reliable machinery for the manufacture of Steel Grit.

(3) Foundries desirous to buy outside the "Ring."

## SITUATIONS VACANT AND WANTED

PATTERNMAKER, young, seeks change of position as Foreman or Assistant Foreman. Sound technical and works experience. Four years moulding shop, drawing and estimating offices. Educated and keen.—Apply Box 434, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

FETTLING-SHOP Foreman for large steel foundry. Write stating experience and salary required to Box 428, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED. — Experienced Moulder, acquainted with aluminium foundry practice, for the production of automobile castings. Able to organise foundry, make own metal patterns. Payment on production basis. Splendid opportunity for capable man. State full experience and position occupied, together with wages expected.—Box 426, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

WANTED.—Foundry Manager used to general engineering castings with plate-moulding experience. Output 12-15 tons weekly. Must be good organiser and strict disciplinarian. Apply, stating qualifications, age, and wage required, to Box 424, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

YOUNG Engineer, about 24 years of age, to act as assistant to steelfoundry manager. Foundry experience not essential. Particulars to Box 430, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

## AGENCY

AGENCY wanted for Malleable or Steel Castings by foundry representative with good sound connection.—Box 420, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

## MACHINERY

WANTED.—"Dwarf" or "Emergency" cupola, capable of melting 1 ton of iron per hr. New or second-hand. Also fan equipment. State separate prices to Box 432, Offices of The Foundry Trade Journal, 49, Wellington Street, Strand, London, W.C.2.

SAND PLANT.

PNEULEC motor-driven portable Disintegrator, £24.

PNEULEC Oil-sand Mixer (new), £22.

No. 1 Simpson Mixer by August, £36.

Borrman Coreblower by August, £160.

MACNAB Sand preparing Plant complete; as new; cheap to save removal.

PNEULEC Rotary Sand Dryer, 20 ft. long, 4-ft. Evans Sandmill, self-discharging, £21

A. HAMMOND,
14, Australia Road, Slough.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hr. New Worm-geared Ladles, 5 tons, 25 cwts., 15 cwts. and 10 cwts. capacity. Ungeared Ladles, 15 cwts. and 10 cwts. capacity. Improved Cupola Spark Arresters.—T. Davies & Son, West Gorton, Manchester.

## MACHINERY—*Continued*

CUPOLA, 3 ft. dia., by Constructional Eng. Co., Ltd.; latest type, complete with staging, blower, and all accessories; supplied new last year and guaranteed equal to new; cheap to save removal; lying Birmingham.—A. Hammond, 14, Australia Road, Slough.

MORGAN P3 Pit Furnace; oil-fired lift-out type for 150-200-lb. crucibles, complete with burner, but without lining. £20 for quick sale.—Rhodes, Queen Street, Romford. Telephone: Romford 95.

TILGHMAN Sand-blast Cabinet Plant, also Tilghman Sand-blast Barrel Plant for sale; cheap to save removal; lying Birmingham.—A. Hammond, 14, Australia Road, Slough.

### SANDBLAST PLANTS

**Room Plants, sizes 12 ft. x 12 ft., 12 ft. x 9 ft. and 6 ft. x 6 ft., made up in cast-iron sections.**

**Barrel Plants, 30 in. dia. x 36 in. long and 30 in. dia. x 18 in. long rotary barrels.**

**Cabinet Plants, in sizes 4 ft. x 4 ft. x 4 ft., 36-in. dia. and 30-in. dia. operators' cabinets.**

**Most of the above by Tilghman and complete with Air Compressors.**

### HAND MOULDING MACHINES

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